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hundred times over in the money
ve.

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inent inventor in Italy discovered
cret of the fool-proof, non-elec-
pinningwheel adding mechanism
this machine. He had been trying
rs to develop a real adding ma-
t a price for everyone . . . even
-poor Europe. NOT another flat
adder that requires you to read
nstructions before you can begin
ate it. Instead . . . he wanted a
sk type adding machine . . . that
could operate, even a child . . .
ould be automatic . . . fool proof
nd, above all, within the pocket-
f everyone!
nd the answer after studying the
g wheels inside electric comput-
chines. He came upon a way to
person's hand supply the 'power'
wheels . . . instead of electricity!
nagine! He invented an adding
e designed so that the gentlest
makes the wheels inside turn!
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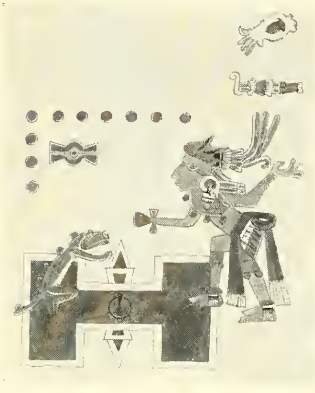

Natural History

Incorporating Nature Magazine

THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Vol. LXIX JANUARY 1960 No. 1

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COVER: One of the paintings in the Mexican *Codex Fejérváry*, depicting mythical game between a human and a lizard deity, was adapted for this month's cover. Symbols representing names of weekdays surround the figure. At top, *right*, is "day-sign" for water, below it is the glyph for reed. At left, dots represent number of days, and, in the angle they form, is the glyph for motion.

The cover and drawings for an article on Mesoamerican ball games (p. 48) were rendered by Hans Guggenheim. He has painted interpretations, now owned by the Guatemalan government, of the *Popol Vuh*, celebrated Mayan manuscript.

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Lamaist Buddha

n exquisite example of a ibetan altar piece, this ilded Buddha represents The Buddha of Infinite ight." It is about 6" high on black wood base, and it is n authentic reproduction in lvastone of the original in is museum's Tibetan collec-on.

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educed in size from a amous Florentine landmark, is boar is a fine example f classical sculpture. Mount-d on a walnut base, it tands about 6" high. It is ast in Alvastone and fin-hed to resemble the bronze riginal. A truly handsome ddition to any shelf or antelpiece.

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The World of Jewel Stones

y M. Weinstein. 430 pp. An ndispensable reference ook, a jeweler's guide, and feast of good reading for he lover of precious and semi precious stones. It is illustrated with 14 color plates and many more black and white photos, some from the museum's own colection. Chapters on cutting, identifying, buying and prospecting for gemstones.

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by Edward Weyer, Jr. 288 pp. A treasury containing 212 photos (58 in color) and a vivid, enthralling text about the rites and customs of such tribes as the Samoans, Eskimos, Jivaros, Bushmen and many more. See such rare scenes as the scarification ceremonies of the Carajá, torchlight fishing in Java, and a canoe dance in Ponape.

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Reviews in Brie

THE MAMMALS OF NORTH AMERICA, by F. Raymond Hall and Keith R. Kelson. *Ronald, $35.00; 1,083 pp., 2 vols., indexed; 553 figs., 500 maps.*

OCCASIONALLY, a single book in some particular field of natural history emerges as a major event. Such a volume might offer an important new theory, or demonstrate that some widely held belief is no longer tenable. Or it could collect the whole of our knowledge in some particular branch of natural history and try to present this wealth of material simply and fully. A work of this kind—detailed, well documented and complete—can be a historic event in its field. *The Mammals of North America* is such a book.

It should be stressed at once that the authors of this monumental compilation have contributed far more than a new checklist. Their two-volume work does, it is true, constitute a checklist of all the kinds of mammals living from Panama northward in the New World. But into this framework Hall and Kelson have, with a frugal eye for space, packed a great deal of information about these animals as well. The authors clearly believe that what one can learn about any animal remains a bit meaningless until one can know what that animal is; indeed, that the means for knowing the correct identity of a particular mammal are an inescapable foundation for knowing, or doing, anything else about that mammal. Accordingly, they attempt to provide, for example, keys for identifying each species of mammal, and have prodigally compiled five hundred maps on which the known geographic ranges of the species are shown. To cite one seemingly trivial, but telling, example, no other book in print offers the beachcomber—or the scientist—such an array of drawings of the skulls of porpoises, dolphins, and whales that might be found, half-buried in the sands, on any North American shore.

All in all, Hall and Kelson's *The Mammals of North America* makes a major contribution to biology by its immense scope, thoroughness, and completeness. For the medical entomologist, the game manager, or the ecologist who wants primarily to identify the mammal with which he is dealing, such a contribution is clearly invaluable. The need of such specialists for one authoritative compendium on which to depend for identifications, names, and ranges is superbly supplied. But more generally, this is the outstanding book of its time in North American mammalogy. No other North American fauna of the living mammals approaches it; no recent mammal fauna of any *other* continent or faunal region approaches it; and many years will pr
ably pass before another book appe
to replace it.

JOSEPH CURTIS MOORE,
THE AMERICAN MUSEU

INSECT MIGRATION, by C. B. Willia
Macmillan; $6.00; 235 pp., illus.

THE well-known migrations of cert
mammals, birds, and fishes are
cinating, intriguing, and perplexi
Less well known, but equally incredi
are the migrations of the winged lepid
terous insects, the butterflies and mo
many of which fly hundreds of miles o
land and water with amazing consta
of direction. Their flights are here c
prehensively chronicled by the Bri
entomologist C. B. Williams, who surv
their activities and compiles excell
records from all over the world, list
points of departure, flight paths,
final destination.

Unfortunately, nothing more is d
with these data, which challenge the
vestigator to analyze and interpret t
significance in the adaptation of the
ganism. A few ideas are suggested
how environmental conditions, such
wind, temperature, and light influe
migrations; yet, in the final analy
there is no consistency in response
these various situations among diffe
species. Some obviously respond, ot
do not, so the environmental fac
cited are not wholly explained.

What, then, are the other facto
Here, the author fails to utilize all
evidence available from other migra
and non-migratory species. Physiolog
and behavioral evidence of insects'
sitivity to various stimuli—even if the
sects do not fly—might have sugges
some mechanisms used by migra
butterflies. A more thorough explora
of early environmental conditions mi
also have given clues about response
stimuli and about the factors which i
ate migrations. For example, in
locusts, conditions of early environm
give rise to either migratory or soli
species, depending on the popula
density. A survey of early developm
and surrounding conditions might h
led to further insight into the probl

Dr. Williams compares migrat
birds with migratory butterflies. Thi
useful, but the factors involved in
migrations are not necessarily simila
those of insects. The sensory-resp
systems of each group are unique to
group, and even though the phenome
is called migration in both cases,
should not imply that the same biol
cal systems operate. Similarly misl
ing is the title of the book, as only

r deals with types of migrant in- other than lepidoptera. Notably g are references to the migratory ients of army ants.

last chapters are devoted to the r techniques of studying migration, by Dr. Williams hopes to encour- nateur entomologists to record and t their observations to appropriate s of study.

Evelyn Shaw,
The American Museum

Journal, by Raymond B. Cowles. *rsity of California Press, $6.00; ɔ., illus.*

BIASED accounts of Africa are ex- eptional, but the author of *Zulu al* has rather extraordinary quali- ns. Born in Natal, of American ts, he received his early education rica but attended college in the d States, spending two additional of biological investigations in n before he began his teaching r at the University of California at ngeles in 1927. Sporadic visits to n over recent decades have sharp- is awareness of the changes taking These, in essence, are the theme book, and they are noted with a poignant nostalgia; we can never e country as Cowles saw it barely years ago.

vitably, the author comes to grips problems arising from the misuses d. soil erosion, and the conflict of in the maintenance of wilderness Can a natural wilderness be sus- l in perpetuity without including, fauna, the kind of man who was mental in destroying precisely the tions we seek to preserve? When ssing such problems. Cowles' writ- ems formal. unlike the active, pic- prose that he uses as a naturalist that sets the book's tone: warm enerous.

Charles M. Bogert,
The American Museum

Road to Man, by Herbert Wendt. *leday, $5.95; 431 pp., illus.*

IS is another of those epic journeys p the evolutionary ladder, with the red aim of showing that man is a of nature, like any other organism, hat the creatures forming this inter- ed whole are alive, not skeletons labels attached. Books like this ys contain errors, and the present ne is no exception. In addition, the or has been able to discuss only a examples under each heading, with esult that his work may seem a bit y and a bit hurried—more like a sity shop than a sustained narrative. said, Wendt writes with warmth sympathy; his book is both informa- and interesting, and it is very well ided with photographs.

Mountains in the Sea, by Martin Holdgate. *St. Martin's, $5.50; 222 pp., illus.*

THE story, told by one of its leaders, of a scientific expedition to Gough Island, in the South Atlantic. The book, which is written with modesty, should prove fascinating to those interested in the still untrod regions of the earth. It begins with an account of the scientists' stay on Tristan da Cunha, 230 miles to the northwest of Gough Island. and describes that island and its people in some detail. Moving on to uninhabited Gough Island for a six months' stay, the expedition surveyed, bored into bogs, and recorded bird. seal. and plant populations in a spirit, the reader gathers. of intelligence, patience, and enthusiasm.

Northwest to Fortune, by Vilhjalmur Stefansson. *Duell, Sloan and Pearce, $6.00; 356 pp., illus.*

THIS thorough, studious account, will recommend itself to all those interested in the history of exploration, as well as in the Arctic. a region now being eyed by nations on two sides of the world. The distinguished author has used materials from many sources, including some thoroughly absorbing journals of eighteenth- and nineteenth-century explorers in the northern reaches of Canada. He gives a full sense of the scope of these and other explorations, and the quest, as Stefansson relates it here, has a real grandeur.

The Last Paradise, by Helmut Handrick. *Chilton, $12.50; 158 pp., illus.*

IN a world increasingly dominated by the will of man—translated by man into the will of God. Life. or Scientific Ascendancy—there is an inclination in some quarters to look upon nature as if it were unreal—subject. therefore. to romantic fancy. *The Last Paradise* yields to this inclination — appropriately so, since the book concerns a relatively untouched area, a private estate in the middle of the industrial Ruhr Valley. And the result—as with perhaps all the provinces of paradise—is the same feeling of unreality: we are on the outside looking in. Despite this drawback, or perhaps because of it, the book is written with fervor and has a wealth of handsome color photographs.

The Fossil Book, by Carroll Lane Fenton and Mildred Adams Fenton. *Doubleday, $12.50; 482 pp., illus.*

THIS is probably the most commodious volume on the subject of fossils now available to the general reader. There is scarcely a page that lacks illustration, which is sometimes in color, and the subject is explored in a direct and well-reasoned manner. Very little is left out that might contribute to an elementary education pleasantly gained.

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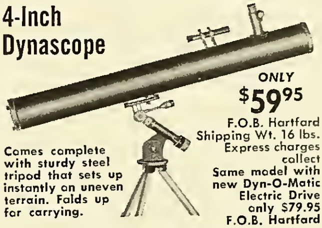

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THE LANDSCAPES

America's largest and next-to-newest state is a land of startling contrasts and beauty

By Thomas M. Griffiths

When the summit of Mount St. Elias was sighted from the Gulf of Alaska on July 16, 1741, by the lookout on board Vitus Bering's tiny vessel, the "Saint Paul," a historic discovery was made for Western man. Bering could not appreciate his discovery; he was ill. He saw only the great difficulties of the return trip to Kamchatka. The naturalist on board, G. W. Steller, reports Bering's comment in part: "We think now we have accomplished everything, and many go about greatly inflated, but they do not consider where we have reached land, how far we are from home, and what may yet happen; who knows but that perhaps trade winds may arise, which may prevent us from returning? We do not know this country; nor are we provided with supplies for a wintering."

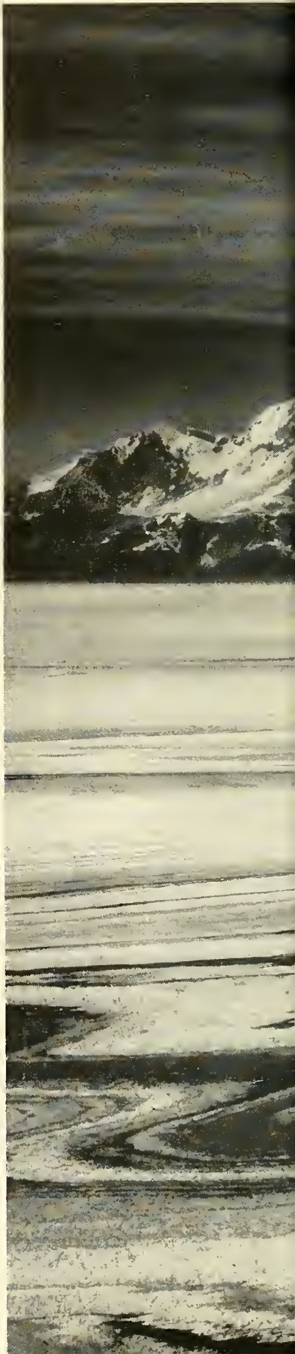
Perhaps some foreboding over his impending death was already coloring Bering's outlook: subsequent visitors to the scene have usually taken a more cheerful view. Actually, Bering never saw more than the barest margin of his discovery. Only gradually did his successors in discovery spell out the magnificent extent of the land that he regarded with apprehension.

Could Bering have looked beyond the 18,000-foot mountain, whose summit shimmered across the vacant miles of stormy sea, he would have seen a vast, sprawling territory without a counterpart anywhere in the world, truly a land of superlatives. To sum them up: The highest summit in North America—20,300-foot Mount McKinley—vaults into the brittle sky above the central Alaskan lowland; some of the rainiest slopes on this continent rise from the fiorded coast of southeastern Alaska; stations in Alaska's interior consistently report the continent's lowest winter temperatures; the whole northern half of the area is underlaid by permanently frozen ground. Even the fauna and flora join in this spirit of superlatives. The world's largest carnivore, the Alaskan brown bear, inhabits Kodiak Island and the nearby Alaskan mainland. Cabbages as big as washtubs and strawberries as big as teacups are regularly recorded. Because of the far northern latitude, the shortness of the growing season is offset by eighteen to twenty-four hours of sunlight during the summer months.

Now this exotic Territory has become our largest state. Not to be outdone by Texas, Alaskan "tall tales" bear a stamp of their own. A few years ago, during the height of summer, an Alaskan mosquito is said to have landed on one of the runways at Fairbanks' Ladd Air Force Base and gratefully taken on five hundred gallons of gas before the ground crew discovered they were not refueling a medium-range bomber. The collection of legends goes on endlessly, as professional Texans are learning to their occasional chagrin.

What sort of land is Alaska? Above all it has variety. From the "banana belt" of the southeast panhandle (map, pp. 8, 9) to the frigid coastal plain in the north, it runs a gamut from a temperate, West Coast marine climate to that of the arctic tundra. In surface features, too, it shows a similar, wide variety.

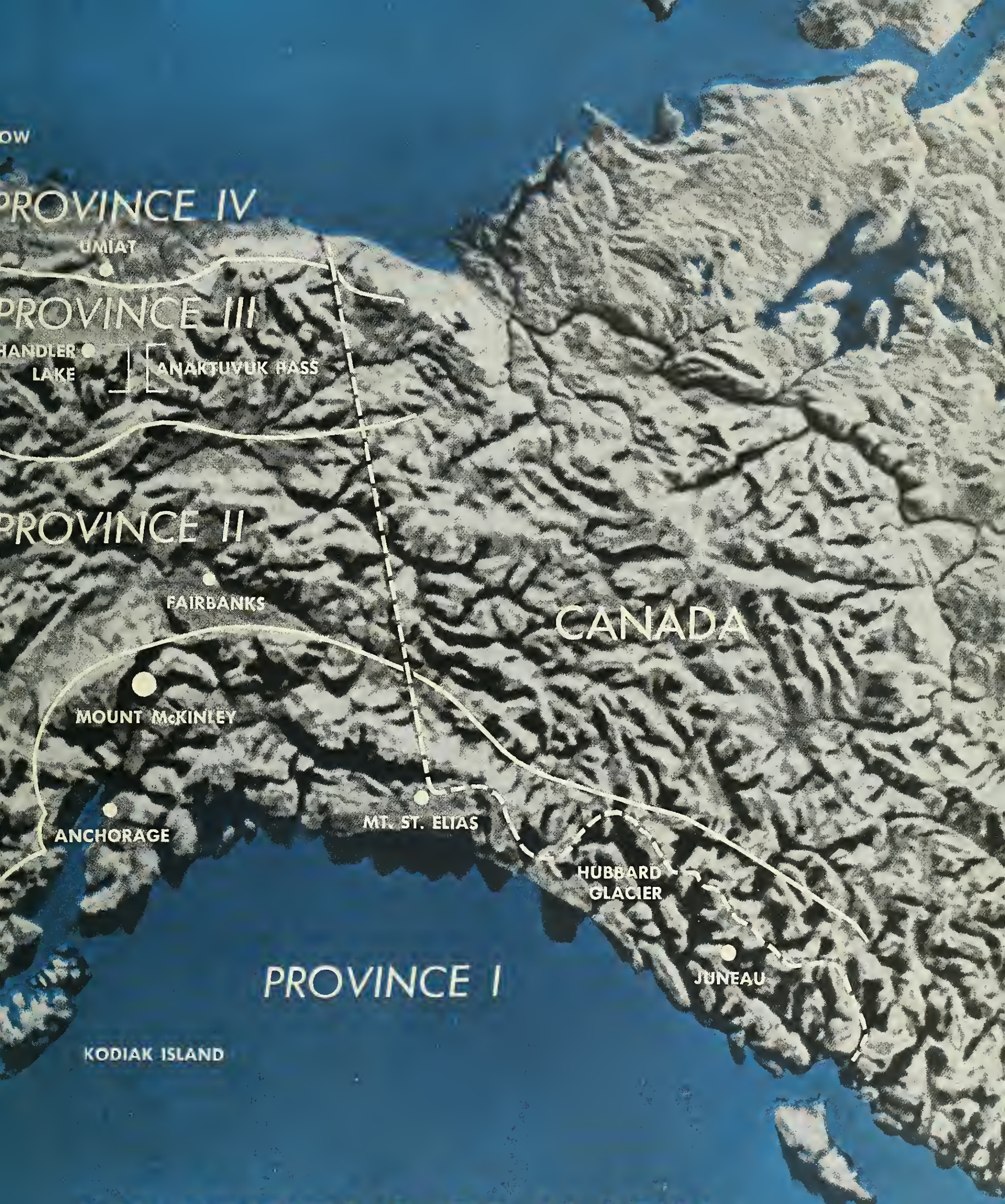
Here is the northwest terminus of the North American continent. It contains the partly hidden framework of the continent's western structure—if indeed that framework stops at the strait and sea that bear Vitus Bering's name and does not emerge again beyond these waters to continue into Siberia. Within Alaska's borders are found four major physiographic



Mount St. Elias towers over Malaspina Glacier, to left in the photo opposite.

OF FAR ALASKA

U. S. S. R.
SEWARD
PENINSUL
NOME
BERING SEA
ALEUTIAN ISLANDS
ALASKAN PENINS
GREAT SITKIN VOL.
SHISHALDIN VOL.


OW
PROVINCE IV
UMIAT
PROVINCE III
HANDLER
LAKE
ANAKTUVUK PASS
PROVINCE II
FAIRBANKS
CANADA
MOUNT McKINLEY
ANCHORAGE
MT. ST. ELIAS
HUBBARD
GLACIER
JUNEAU
PROVINCE I
KODIAK ISLAND

THE REGIONS OF ALASKA

Alaska is divided into four physiographic provinces — from south to north, the Pacific Mountain System, the Interior Hills and River Valleys, the Brooks Range, and the Arctic Coastal Plain. Each of these four provinces continues some feature of adjacent continental areas.

Dr. Griffiths, an associate professor in the geography department of the University of Denver, has traveled often in Alaska, and took several of the photographs that illustrate the article here. He is currently spending the academic year in Sweden, under a National Science Foundation grant.

provinces. Each is an extension of a region that is recognized farther south and east in Canada and the United States proper. From south to north, these provinces are: the Pacific Mountain System, the Interior Hills and River Valleys, the Brooks Range, and the Arctic Coastal Plain.

The first of these provinces—the Pacific Mountain System—corresponds to the Cascade–Coast Range–Sierra Nevada Complex that distinguishes the states of Washington, Oregon, and California. The second—the Interior Hills and River Valleys—have their counterpart in the intermontane valleys of British Columbia, the Columbia Plateau of Washington, Oregon, Idaho, and the Basin and Range province of Nevada. The third—the Brooks Range—is the northwest extension of our continent's Rocky Mountain System. Finally, the Arctic Coastal Plain has its physiographic (if not its climatic) counterpart in the plains of Kansas and the Gulf coastal plain of Texas.

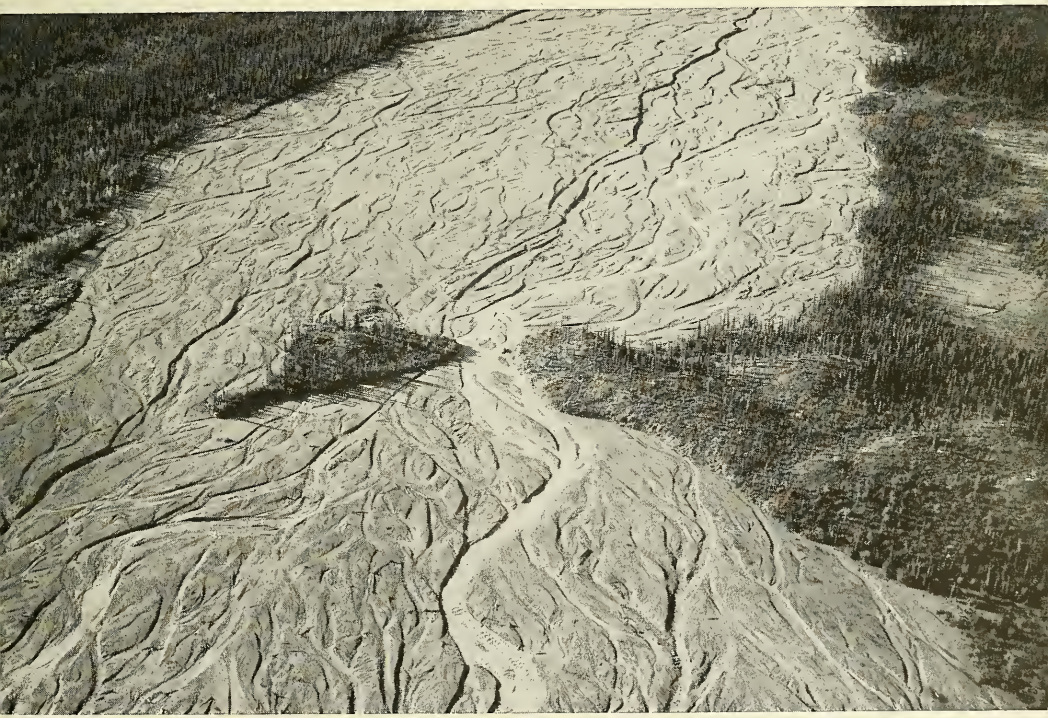
For reasons of structure, regional geology, and the morphology of the land, the physiographer divides these four major areas into subregions and provinces. For our purposes, the fourfold framework will suffice, although we will occasionally refer to some smaller features.

The Pacific Mountain System is a complex province. It contains both the highest mountains in Alaska and an active volcanic belt. These two parts are of quite different natures. The Aleutian chain—which serves as a sort of fine-meshed barrier between the Bering Sea and the North Pacific—contains some eighty recognizable volcanoes, of which at least forty-seven are active. Like a fragmented tongue, the Aleutians flick out westward in a 1,600-mile arc toward the Asiatic mainland. Here, on a basement of young rocks formed only yesterday from white-hot ash and molten lava, stands a procession of smoking cones and steaming calderas. This is a very much alive sector of

Shishaldin Volcano, *above*, among eighty-odd Aleutian volcanoes, lies in smoking quiescence. But forty-seven the Aleutian volcanoes remain activ

Great Sitkin Volcano, photographed in June, 1946, still has cinder and lava dome left by eruption in March, 194 Volcanoes ring much of Pacific Basi

rd Glacier, in Yakutat Bay area heastern Alaska, is seen, *above*, with Mt. Hubbard rising almost 15,000 feet in background. The glacier's snout protrudes into the sea, and ice blocks constantly break off to drift as bergs.



y River, on north side of Mount nley, has left this braided stream channel. Streams, formed by water that drains from glacier's snout, are easily blocked by silt that glacier's erosion amasses and must often change course.

Mount McKinley—at 20,300 feet, the highest summit in North America—is here seen from northeast, at juncture of two glaciers. Pacific Mountain System, of which it forms part, is southernmost of Alaska's physiographic province

the terrestrial ring of fire that girdles the great Pacific Basin from the Philippines to Tierra del Fuego.

Along this weak, border zone, the earth's interior fires can—and often do—burst to the surface. At the root of the Alaska Peninsula in 1912, for example, the cone of the Katmai Volcano collapsed into a void that had been its base. The void was produced by the expulsion of over two and one-half cubic miles of ash and pumice from the adjacent volcanic cone, Novarupta. The finest particles from the great cloud produced by this eruption floated completely around the earth. Today, a glaciologist—whether in Greenland or in Antarctica—can recognize by the particles of ash in his drill cores the layer that fell as snow in 1912; and that has since been buried and consolidated into glacial ice under an overburden of forty-seven years' accumulation.

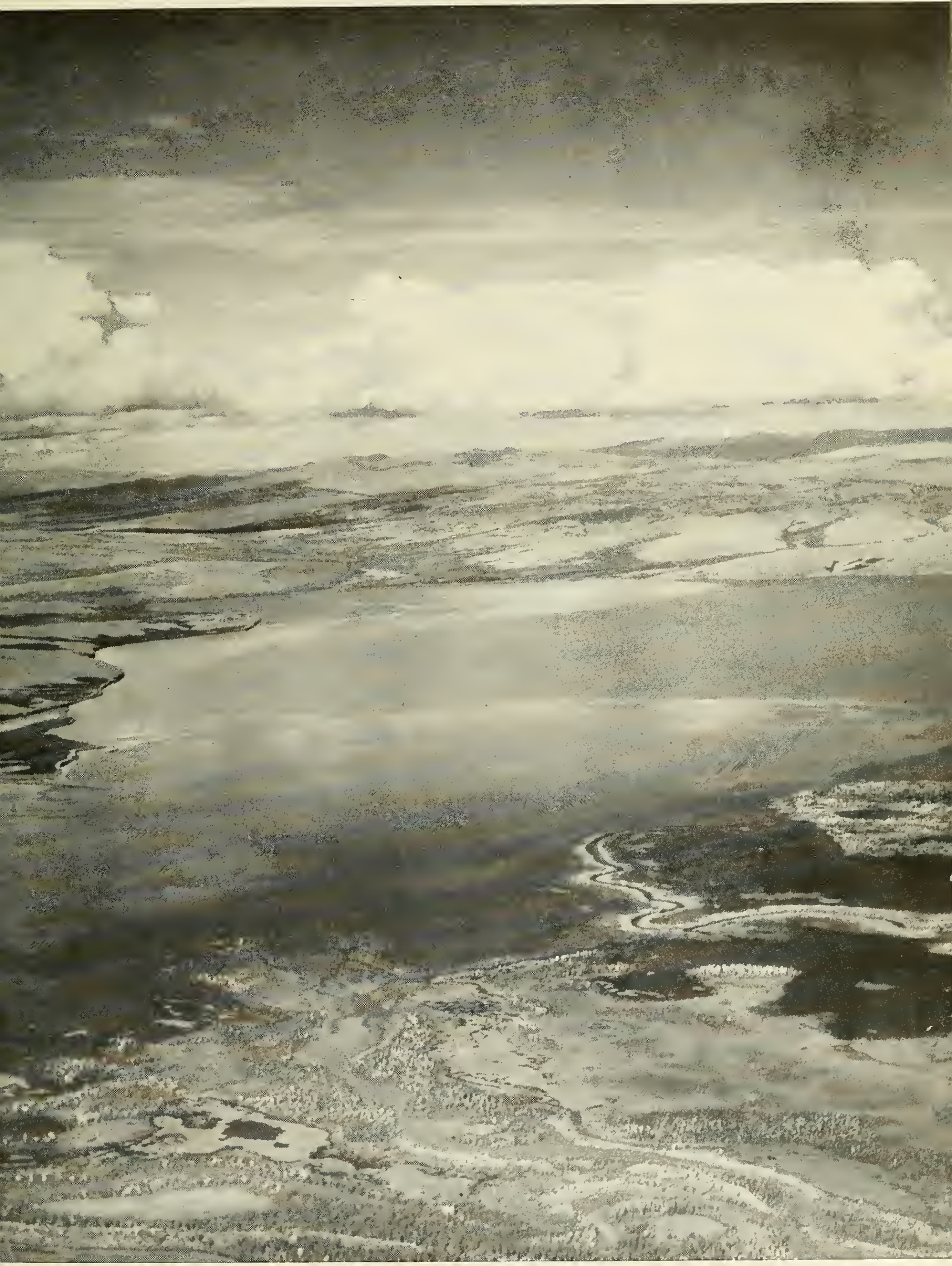
Mount Spurr, at the very root of the Alaska Peninsula, marks the eastern terminus of the Aleutian volcanic chain. The rugged peaks of the Alaska Range to the north, and the less rugged mountains of the Kenai Peninsula to the south, clamp shut here on the root of the Aleutians like the jaws of a great vise. Farther east, the two jaws hinge in a complex mountain zone, which trends east and southeast—into Canada and eventually into the U. S., where it extends into Washington, Oregon, and California.

This region does not contain a *single* mountain range (as is essentially true of the Aleutian chain), but rather a whole series of overlapping mountain and valley structures, which make up a zone widening at some points to well over two hundred miles and, at others, narrowing to less than fifty. The overlapping mountain groups have been carved from intensely folded sedimentary and metamorphic rocks, into which have been injected batholithic masses of granite and similar igneous intrusions.

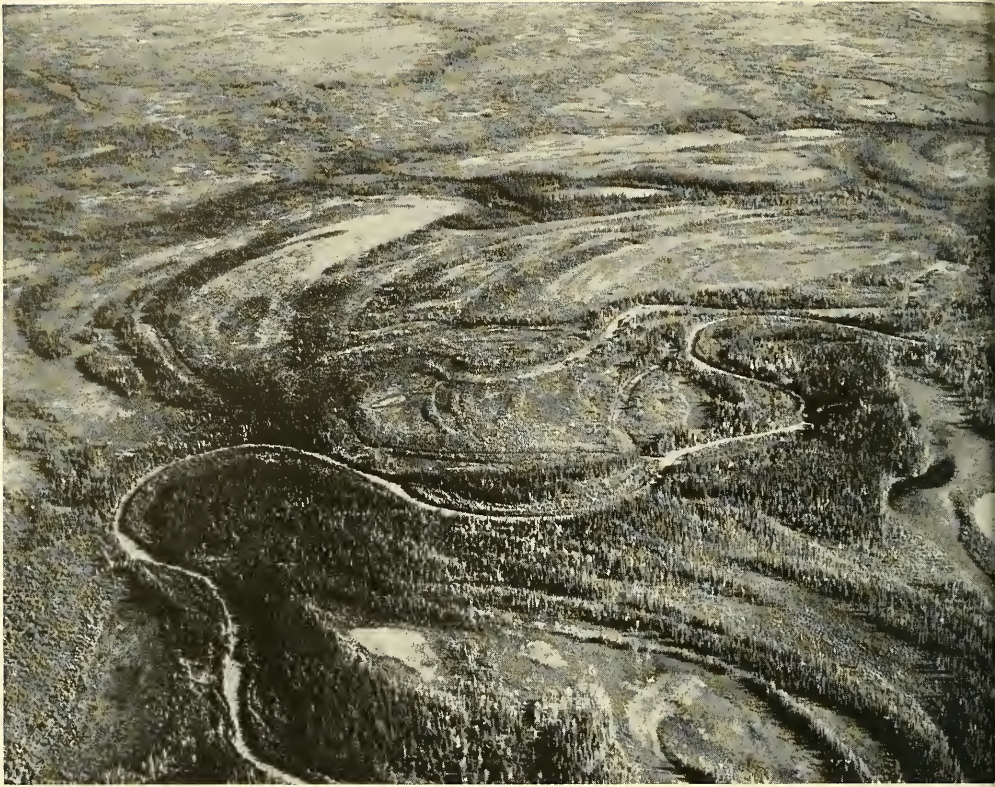
In many cases, these granitic masses serve as the resistant cores from which water and ice have carved the highest peaks. For example, the great mass of Mount McKinley (as we have noted, North America's highest peak) has been sculptured from such a mass of pink and gray granite, which—during Mesozoic times—was injected from below into the dark, pre-Cambrian rocks of the Alaska Range. Today the exposures of th single granite batholith cover son one hundred and eighty square mile Yet, at the very summit of the mou tain are found somber remnants the old host rocks into which th granite was injected. At few plac in the world is such a great vertic thickness of granite exposed to view no less than fifteen thousand feet c the south and southwest flanks this enormous mountain.

On the steep slopes of this mou tain zone, scores of alpir glaciers have their source. These we away the summit ridges and cra lethargically down the valleys to en their careers either in a morain choked jumble at the foot of the hig peaks or calving their bergs into tl sea. Few regions in the world off more spectacular examples of mou tain glaciation (photograph, *above*

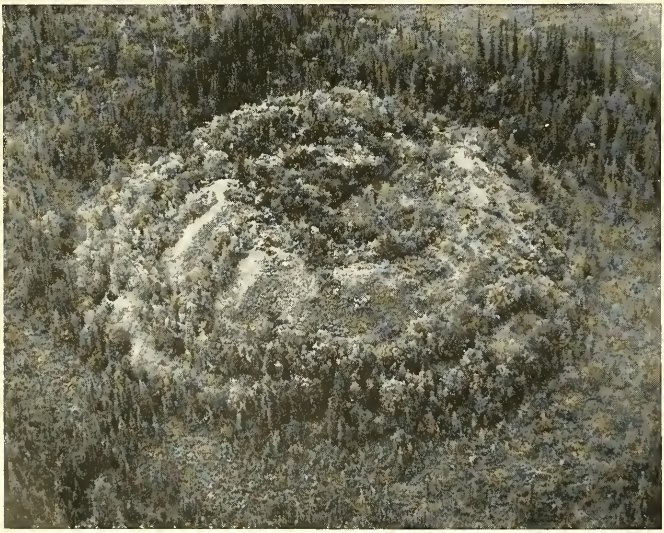
Only reluctantly is the great ba rier of the Pacific Mountain Syste broken by routes to Alaska's vast i terior. The Aleutian chain, becau of narrow passages and foul weath along the meeting place of cold arct and warm Pacific waters, has alwa hindered navigation. Only the Susit



ING COUNTRY typical of physiographic zone of Interior and River Valleys is seen in this view from valley of upper Kuskokwim River—with Yukon, one of the two main rivers serving country of low hills and tree-dotted plains.



Flood plain west of Fairbanks is cut by small river that flows toward main stream. Disposition of stands of spruce and birch accent meander scars left by channels that t
river has dug during past centuries, as its course shifte



Pingo, a kind of large mound often found in Arctic regions, is seen, *above*. Pingos are made by expansion of water when it freezes in the saturated subsoil.

River–Cook Inlet lowland, the Copp
River lowland, and the narrow pass
at the head of Lynn Canal (abo
Skagway and Haines) offer grudgi
access to the regions beyond.

In 1898, the Klondike miners w
struggled over the Chilkoot and Wh
passes into the interior negotiat
the barrier at a point so formida
as to be a measure of their gold-lu

Once beyond the Pacific Mou
tain System, the visitor reach
the province of Interior Hills a
River Valleys. Pictures of this terra
are less likely to grace the cover
Alaskan travel folders than are t
alpine scenes from farther south. Y
there is a subdued dignity about t
region that comes in large part fro
its sheer expanse. Here, two gre
arctic rivers—the Yukon and Kusk
kwim—gather together hundreds
tributaries, not only from the nor
flanks of the Pacific Mountain Sy

but also from the south flanks e Brooks Range, and sluggishly er their accumulated burden to g Sea. Along the way, they me- r over spruce- birch- and alder- ed flood plains and sometimes oldly through a ridge line.

e hills are subdued for the most although here and there an d zone has been fretted by glaciers. Seldom do elevations twenty-five hundred feet. Even at height, the summits are above erline, and are clothed in a green rown carpet of tundra and frost- rock. Timber is to be found in the river bottoms and along ower slopes of the hills.

ELL over half of this area is underlaid by permafrost. The is shallow and saturated with r during the brief summer thaw. ted black spruce is the tree best ted to these severe winters, shal- oils, and short growing seasons: not uncommon to find a four- spruce trunk that shows well over ndred annual rings.

the long winter, the great rivers l the uncounted, curving sloughs occupy cut-off meander scars— e solid. In pioneer days, the n rivers served as obstacle-free ways for the dog-team driver. In g, the ice melts slowly, but tually "goes out" in a great flood stling cakes that sometimes over- the banks—plowing out timber anything else in their way. For al months the ice is gone. Then, e, motor boat, and, in years the paddle wheel steamer—ply rivers feverishly, laying in next er's supplies. Today, the airplane largely, although by no means ely, supplanted these older modes ansport, winter and summer.

cause summer travel in pioneer was almost impossible except g the major streams, a high per- age of interior Alaska's towns situated on navigable streams. If search for gold carried a pros- or away from this line of com- ications, the streamside settle- t still remained as his return t of contact. Many a road in rior Alaska still runs a short way river dock (or, today, airstrip) ine or placer deposit that has no r connection with the outside.

oday, as one flies over this im- se, interior lowland of Alaska, its

Riverside village by Yukon is seen, *above*. White trails in the foreground were made by trappers. *Below*, another village shows typical haphazard form.

Drift fence traces are found in thin lines, *below*. Made in timbered areas, funnel-shaped fences guided migrant caribou to Indians waiting for the kill.

Exposed layers of sea-deposited sediment, *below*, bespeak upheaval that raised Brooks Range late in Cretaceous period.

Brooks Range, *above*, is seen in view from south. Northe continuation of the Rocky Mountain chain, this range for

features are immediately appare Most prominent are the great rive swinging in loops over their w timbered flood plains. Between th swell the bare, tundra-crowned hi One cannot but be impressed by great, empty spaces of primitive so tude; the occasional settlement see lost in a sea of sloughs, lakes, pon river courses, and the seemingly en less expanse of black spruce fore

In some sections, a flight of h an hour will show no evidence man. This is the region where w ter's grip is felt most severely. clear, cold, winter days, when thermometer hovers near −60°F., moisture in a breath rustles do one's parka front in a fall of crystals. Smoke rises for the fi thirty feet from a chimney withou

ndary zone between treeless Arctic tundra and Eskimos
orth and forested area with Indian population to south.

Geological structure of Brooks Range includes shales, sandstones, and, *below*, limestones tightly compressed.

ver—a perfect cast from the chim-
's mold. Men do not exert them-
es, lest they breathe hard and
t their lungs. On moonlit nights,
howl of a wolf raises hackles,
nswered by sled-dog clamor, and
ries for five miles. This is the
ska of romance and fable.

o the north of this interior prov-
ince lies the Brooks Range (photo,
ve). named for Alfred H. Brooks,
neer geologist in the territory and
mer chief of the Alaskan Branch
the United States Geological Sur-
. This northwestern terminus of
Rocky Mountain System extends
oss the full width of Alaska from
ada to the Arctic Ocean.

efore the airplane made it pos-
e to vault over mountains, the

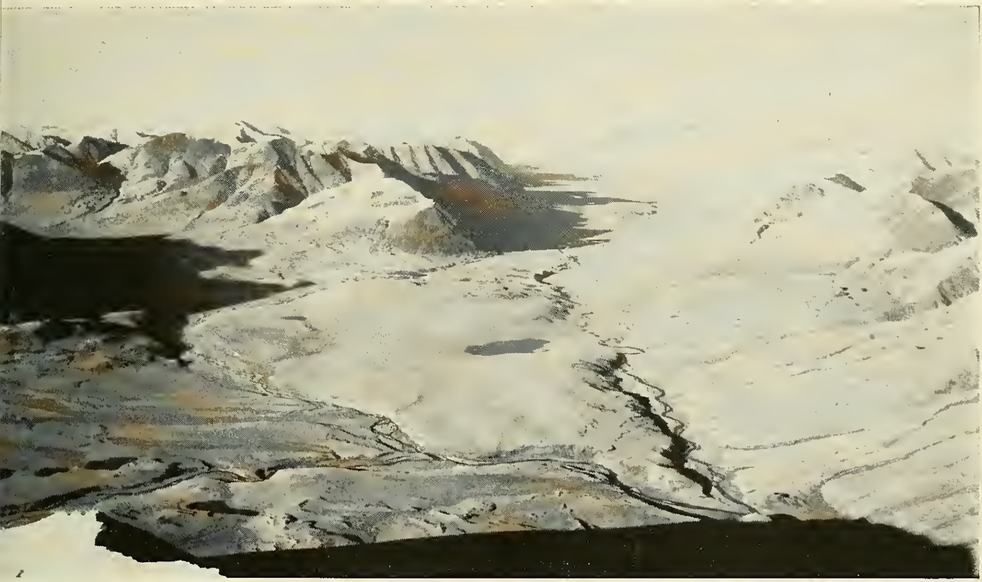
Dall's sheep move in a band across the rugged tundra of the Brooks Range's north flank. Related to bighorn, Dall's is smaller and has more slender horns.

Brooks Range was a sharp barr and zone of demarcation betw Alaska's true arctic environment the north and the subarctic to south. The northernmost trees on North American continent strag up the streams and the south flanks of the Brooks Range and stopped cold there by a climatic b rier. To the north of the ra stretches the treeless tundra of Arctic, until at last it ends at the rim of the Arctic Ocean.

The zone was also an ethnic b rier. South of the range, forest Ir ans eked out a precarious subsiste in the interior lowland. North of range, the coastal Eskimo won hard living on the shores of ocean. Between them lay a divid line both physiographic and cultu The first Geological Survey parties penetrate the Brooks barrier cros it with great difficulty, taking m of the short summer season for mountain crossing and returning civilization aboard some chance wh ing vessel met along the Arctic Co Seldom did Eskimo meet interior dian, except by chance during so extended hunting foray.

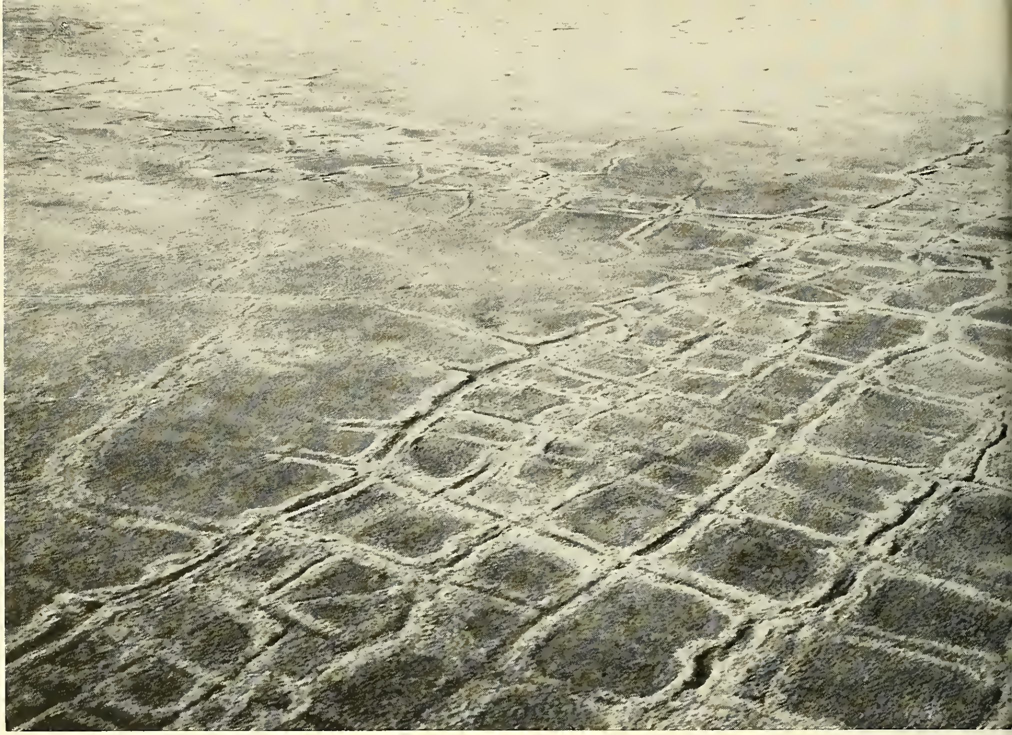
Today, planes cross the Bro Range regularly and land freque within its confines. A group of coa Eskimos have migrated southward the Chandler Lake and Anaktu Pass region. Geologic and to graphic field crews are tracing the physical structure of the ra while botanists and zoologists are amining in detail its flora and fau No longer can the region be classi as unexplored; the probing eye of aerial camera has examined ev foot of terrain. Yet it still rem one of the most inaccessible sec of the Western Hemisphere, and physical framework today is unalte by man from what it was when V Bering discovered Alaska.

In many respects, the Brooks Ra is different from the Pacific Mo tain System to the south. Some these differences stem from the that the Brooks Range seems no have been as heavily glaciated as Pacific system. The highest sum in the Brooks Range is below 10 feet. Being farther from the N Pacific, this region receives m less precipitation. Spared the co quent, intense glacial scouring many parts, it appears more subd than does its southern neighbor.



ктuvuк Pass, seen from south, is principal low-level through the central Brooks Range, linking John River on south with the Colville to the north. It has always been a main avenue of travel, both for migrant game and for man.

ndler Lake, looking south into heart of Brooks Range, pies glacial valley scoured in mountains. It is dammed partly by material left by glacial action, although glaciers affected Brooks Range less than Pacific mountains to south.



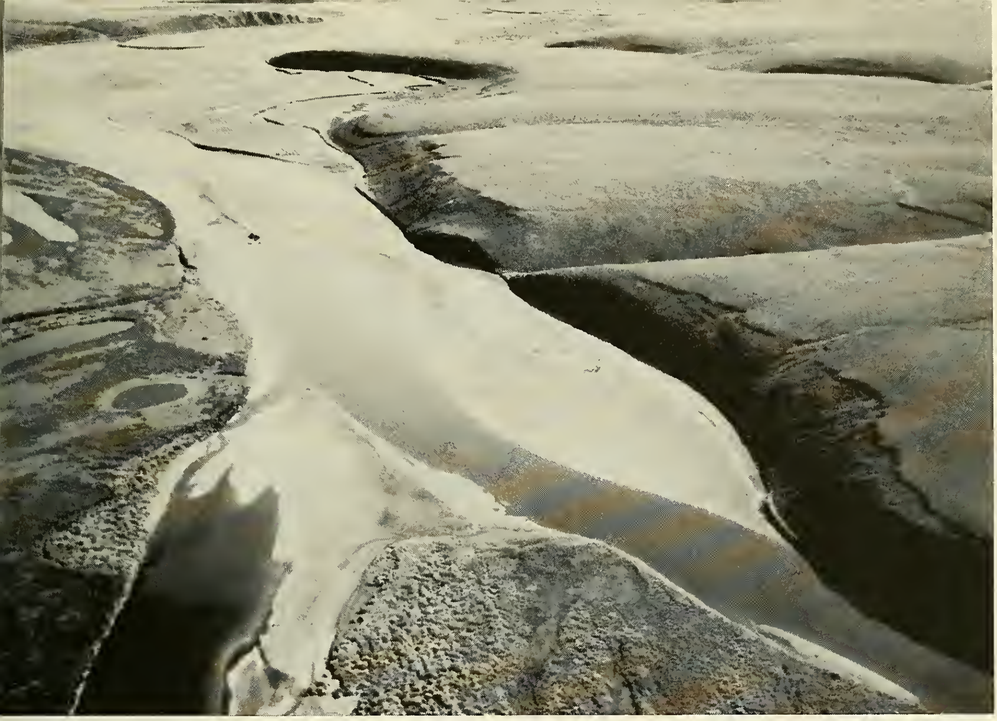
FEATURELESS PLAIN of Arctic Coast near mouth of Ikpikpuk River is dotted, *below*, by meanders, lagoons, and sloughs.

PERMAFROST TERRAIN often consists of polygons like tho *above*, edged by tundra ridges that ice wedges have raised u

A second basic difference is a parent in the nature of the unde lying rocks and the structure of t range. In the geologic past, the pre ent site of the Brooks Range was vast, shallow seaway in which gre thicknesses of sedimentary shale sandstones, and limestones were d posited. Later, these sediments we compressed, folded, and squeez into the present uplift from which t features of the range were carved l the erosion of water and ice.

The folding was intense during t mountain-building period: in ma places it is possible to see tight fol exposed by subsequent erosion on t sides of valleys and ridges (photo pp. 16, 17). The surface coating soil, tundra, weathered rock, sno and ice is thinner here than to t south, allowing the range's geolog bones to lie bare, particularly duri the brief arctic summer.

BEYOND the northern foothills the Brooks Range, the Arct Coastal Plain stretches northward the ocean. In no sense is this a fe tureless plain. Although it is almo

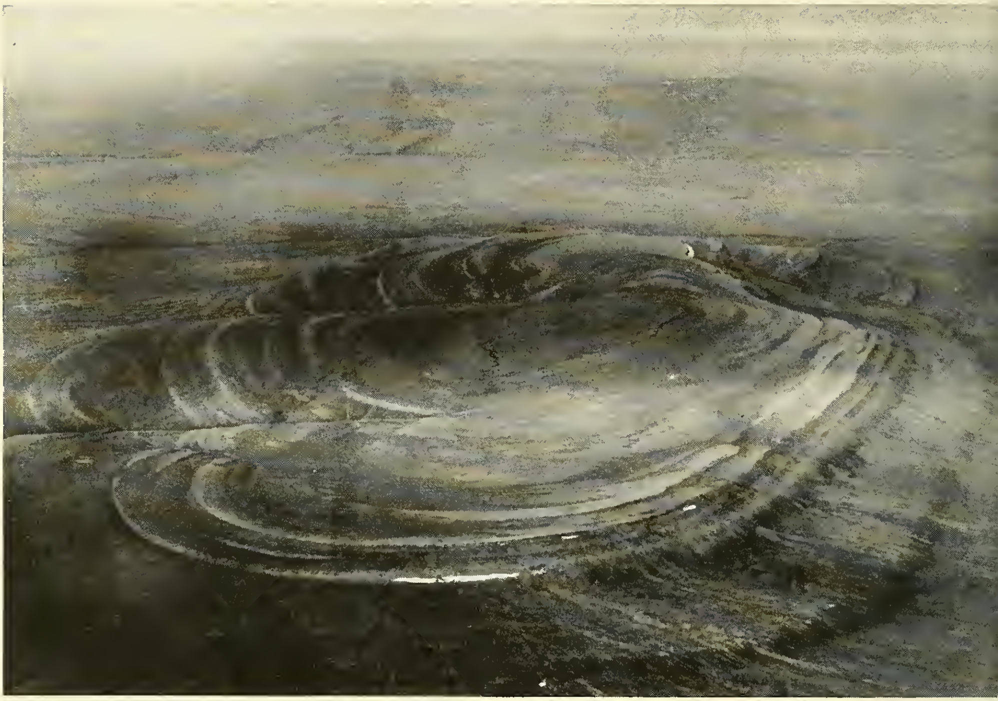


.VILLE **River** looking downstream, *above*, has eroded its it bank more deeply than its left due to Coreolis force.

Town of Barrow lies spread at Alaska's northernmost point, *below*. Pack ice shows offshore, with Arctic Ocean behind it.

, it is crossed by many rivers, of ch the Colville is the most promi- t. Close to the range, these streams e cut narrow flood plains, lined h low bluffs, into the imperceptibly oing surface of the plain. Close to ocean, these streams meander olessly through a maze of sloughs, oow lakes, and lagoons that are ely above the level of the Arctic ean. The sedimentary rocks that lerlie the Coastal Plain have been tly folded in the past into domes, clines, and anticlines. These folded ictures have trapped oil, which is v actively being sought.

Most of the Arctic Coast, from oe Prince of Wales north to Point rrow and from there east to narcation Point, is guarded by shore sand bars. Many of the slug- h streams empty into shallow la- ons behind these barriers. Shore rents are frequently responsible curving spits. During four weeks casionally more) in July and Aug- , a narrow lead of water opens up ween these bars and the drifting, ar pack ice. Along this narrow itlet, whaling ships once made



Rare formation, above, is a closed syncline, a structure caused by folding of the earth and seldom entirely visible.

Oil well site at Umiat on the Colville River, *opposite*,
photographed in April, with ground still deep under sn

their way east as far as the delta of Canada's Mackenzie River.

The entire Arctic Coastal Plain, the Brooks Range, and well over half of the Interior Lowland are underlaid by permafrost. This condition, characteristic of all the lands that rim the Arctic Ocean Basin, sometimes extends far south into the continents. In these regions, all soil moisture and ground water is frozen to great depths—sometimes hundreds of feet. In summer, the long hours of sunshine raise the temperature enough to melt a surface layer ranging from an inch or two to several feet.

This surface thaw leads to complications. All the melt water must be carried away by surface drainage and, in extremely flat areas, such drainage may be inadequate. From the air, these regions look absolutely waterlogged during the height of the brief summer's melt season.

Still another group of phenomena are found in permafrost regions. Seasonal freezing and thawing of the "active layer" subjects the surface to alternating expansion and contraction. These forces create a bewildering diversity of stone nets, stripes, ice polygons, frost wedges, icing mounds, pingos, and frost-heave features. Building foundations settle unevenly, roads buckle or load up with ice mounds. Nature exacts a high price from those who would live and work in permafrost regions.

This, then, is Alaska's land — a sprawling, diversified frontier; a land of incomparably beautiful alpine peaks, of smoking volcanoes, mighty rivers, tundra-clothed hills, frost-marked plains, warped mountains and ice-scoured coasts. The modern traveler is sorry that Vitus Bering did not see more of the land that he discovered. Had he lived until today, at Cape Prince of Wales, he could have looked across the strait that he once navigated and now bears his name, toward the eastward-reaching tip of Asia. Across this bridge—or another nearby to the south—trickled the thread of Paleolithic and Neolithic men who peopled the New World. (In 1741, Bering unknowingly was retracing a route long since forgotte

He could have tarried of a n
summer evening at an Eskimo hu
ing camp beside Chandler Lake
the north flank of the Brooks Ran
to watch a successful hunter bring
a mountain sheep's haunch back
camp, or a fisherman in a kayak l
ing thirty-inch trout from a gill n
a people from antiquity now equip
with repeating rifles, modern fish
gear, and in airplane contact with
distant outside world.

On a midwinter night, he co
have traced the frozen sweep of
Yukon among snow-crusted hills wh
overhead, curtains of blue, gre
and pink aurora rippled from hori
to horizon like a magician's bann

He could have paused by Bi
Creek, to let his gaze leap up, s
by step for thousands of feet, to
top of Mount McKinley—one of
world's truly great mountain walls

Confronted with even these sm
segments of Alaska's seemingly
limited store of physical grande
Vitus Bering's somber views of 1
might very well have been modifi

ELLOWSTONE QUAKE

Montana temblor has made changes in this beloved National Park

By John O'Reilly

N THE NIGHT of August 17, at 11:38 P.M., a shift in the earth's leep under the Rocky Mountains red an earthquake that split 00-foot mountain, sending mil- of tons of rock down into the of the Madison River in south- rn Montana. The giant slide ed the river and trapped or l many campers, taking a toll of ves, with nineteen more persons ng and presumed dead.

id the immediate concern for n life, it was not at first realized he earthquake was not a local omenon but actually affected 550,000 square miles of the sur- ling area. It was, in fact, the h most severe earthquake ever ded in the United States.

ile the avalanche roared down the valley of the Madison, even er changes in the earth's face taking place in other mountain- sections near the quake's epi- r. The greatest of these occurred ellowstone National Park, first most spectacular of America's of outdoor playgrounds. Follow- he earthquake, roads were kept d to visitors while heavy road- ling machines were put to moving sands of tons of earth and rock. October, 1959, fragmentary re- appeared, indicating there had major alterations in this most fa- American vacation land. Pho- pher Richard Meek and I went ellowstone that month to find out what effects the earthquake had on this historic area.

URING our very first day in the park, it dawned on me that Meek I were witnessing the kind of eval convulsion, which, eons ago, created the wonders that millions urists have so long admired. The of the earth was being reshaped at Yellowstone—more drastically, perhaps, than at any time in recorded United States history.

Dozens of mountains had sent massive rock slides down into the canyons. Boulders as big as automobiles had bounced and rolled like marbles down the mountainsides, cutting swaths through the forests, tumbling across roads and into streams. Highways had cracked and shifted. The underground plumbing system of one of the world's greatest thermal regions had been fouled and twisted, causing all sorts of changes in the spouting, boiling hot geysers.

And the upheaval was still going on. Brand-new geysers were sending boiling mud and steam into the air. Old thermal springs were bursting into renewed activity, and a few geysers, active for years, had ceased to spout. Occasional plumes of steam, rising from the forest, testified to the continued activity that was changing the park before our eyes.

HERE are some of the major disruptions that happened during the initial shock, the major aftershocks and the lesser tremors that are still occurring as the mountains gradually adjust themselves to the new fractures in the earth's crust:

Sapphire Pool, in Biscuit Basin, a clear, blue pool that boiled over periodically before the quake suddenly became violently active and now explodes at irregular intervals to send columns of boiling water 175 feet in the air, with clouds of steam rising several hundred feet higher.

Grand Geyser, formerly one of the most spectacular in the park, erupted exactly once after the quake and has not erupted since.

Sylvan Springs, a mile and a half off the highway, produced a brand-new mud volcano on a wooded slope. Its crater is 75 by 50 feet and it churns and pumps continually, throwing out gray, soupy mud and bouncing the tree trunks that fall into it up and down as if they were twigs.

Fountain Paintpot, in the Lower Geyser Basin, demonstrates greatly increased thermal activity. The Paintpot is bubbling and boiling, with new fumaroles sending out smoke and white plumes emerging from cracks in the nearby parking lot.

Mount Holmes, a 10,300-foot mountain, lost part of its northeast face in a rockslide 3,000 feet high and a mile wide at the bottom.

Secret Valley, between Madison Junction and Norris, disgorged a mud slide which came down the mountain and spread out through the forest.

Obsidian Cliff, between Mammoth and Norris, gave way, covering the road with fragments of volcanic glass. Its new face, jagged and shiny, now glistens brightly in the sunlight.

These are only a few of the more dramatic results of the quake. In the course of our week-long stay, traveling round the park and hiking into the woods with some of the first surveying parties to penetrate these areas, we saw many more.

The most astonishing of the new developments is the activity of Sapphire Pool. Before the quake, the water in this 30-foot crater was a beautiful blue. During its miniature eruptions it sent small quantities of water gurgling out among odd-shaped limestone deposits called "biscuits."

It continued this activity for several weeks after the initial quake. Then, following one of the aftershocks on September 5, the pool began erupting violently. In seventy-two major eruptions at about two-hour intervals it sent boiling water 75 to 150 feet high. This action stopped on September 13, and the pool subsided to a violent boiling until September 29. At 6:35 P.M. on that date another tremor occurred and Sapphire went into action again. Since then it has continued to erupt at intervals of thirty minutes to one and a half hours.

DURING my investigation of earthquake results in the park I spent parts of three days watching the fascinating behavior of Sapphire. The great limestone mound in which the

LOWSTONE PARK'S facade alters as ult of avalanches, new geysers and mud reveals earthquake's violence.

Mr. O'Reilly and Mr. Meek went to Yellowstone some weeks ago on behalf of Sports Illustrated to see what damage the August, 1959, earthquake had done. Their report is reprinted here through the courtesy of Sports Illustrated (copyright, Time, Inc.)

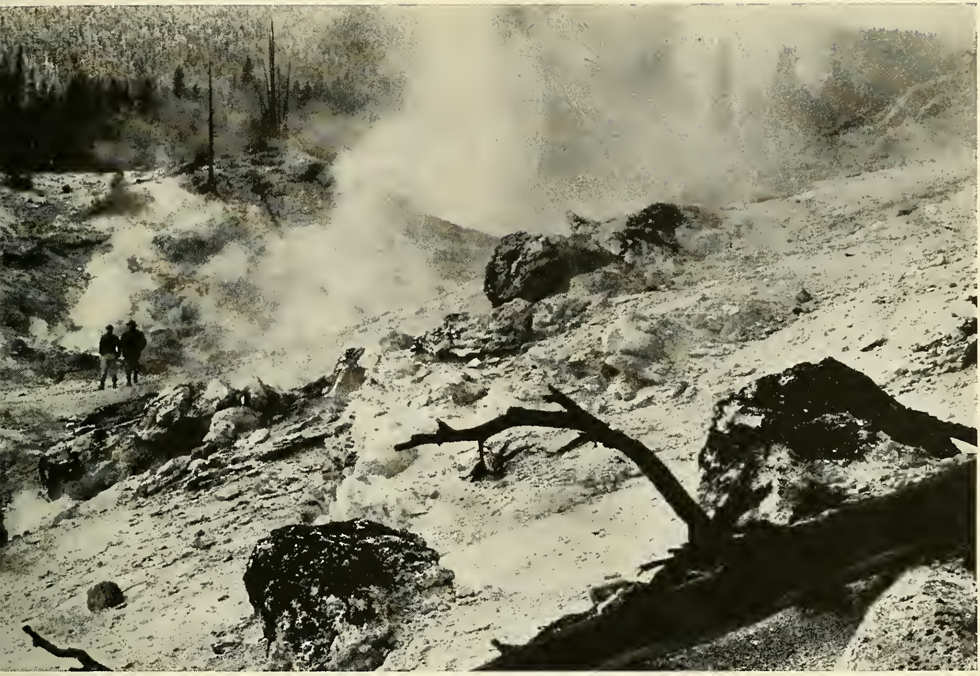
crater is located was scoured by the hot floods of successive eruptions. "These limestone biscuits around the pool used to be a beautiful green," explained Robert N. McIntyre, the chief park naturalist. "Now you can see that the big eruptions have burned them to a dull gray and the limestone layers over the whole mound are being flaked off" (photo, p. 28).

Steam rose from the water as the pool slowly filled before each major outbreak. I watched a number of these but none was as great as the eruption I was to see at 3 P.M. on October 18.

At that time I was standing about seventy-five feet from the rim of the crater, a distance that had proved safe during previous eruptions. Meek had his camera set up considerably farther away. There was an eruption of some thirty feet and then Sapphire remained quiet for three-quarters of an hour. Water bubbled in the crater and small plumes of steam rose over the rim. Suddenly there was a loud sound—a great thump. The ground vibrated enough to buckle my knees. Then the whole pool seemed to rise, with jets of water shooting high into the sky. A wall of boiling water rolled directly toward me.

Feet got the better of curiosity. I turned and started sprinting down a path of cinders that had been put there for closer access to the pool. I could hear the hissing wall of water close behind. Glancing skyward I could see nothing but white steam. Looking down as I ran I saw fingers of bubbling water boiling up onto the cinder path from either side. Running this gantlet, I at last reached the safety of a boardwalk.

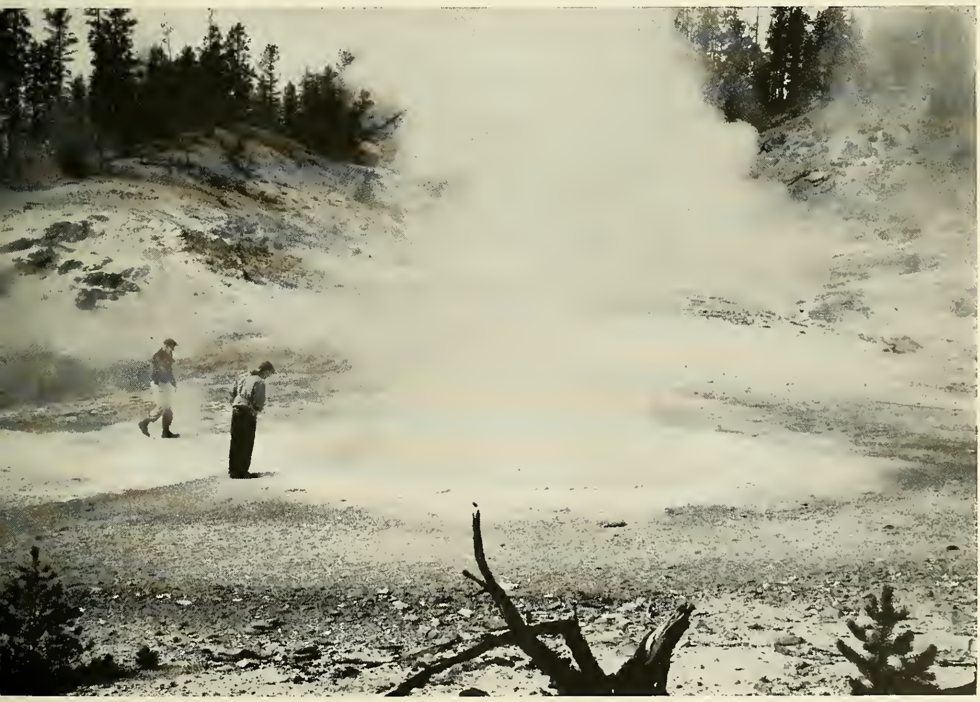
Breathless, I turned and looked back. The entire mound was awash with hot water. It covered places that had not been covered by previous eruptions. It cascaded in sizzling waterfalls into the craters of other thermal pools and it was still steaming when it washed into the Firehole River 100 yards away. The eruption had sent water jets at least 175 feet into the air—probably higher.

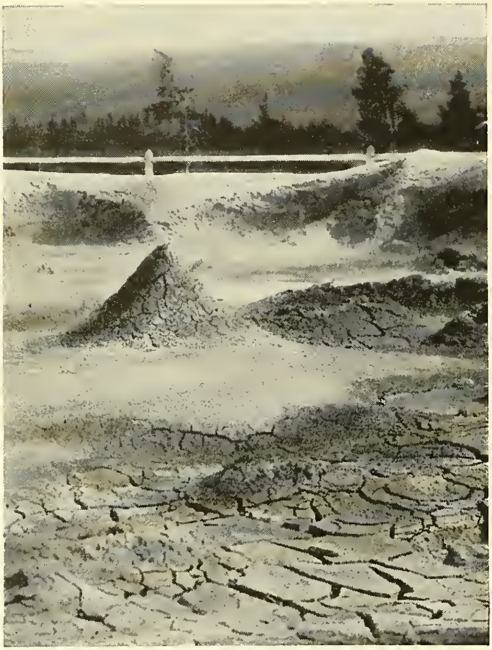


REAK near Sylvan Springs, *left*, ns fallen trees in its mud caldron.

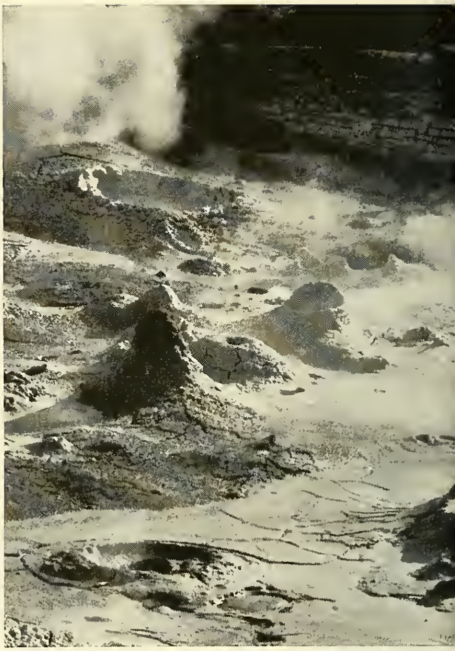
AUTOMOBILE-SIZED boulders, *above*, cut massive swaths down mountainsides.

IN THERMAL BASIN, *below*, yellow water boils sulfurously in newly formed pool.

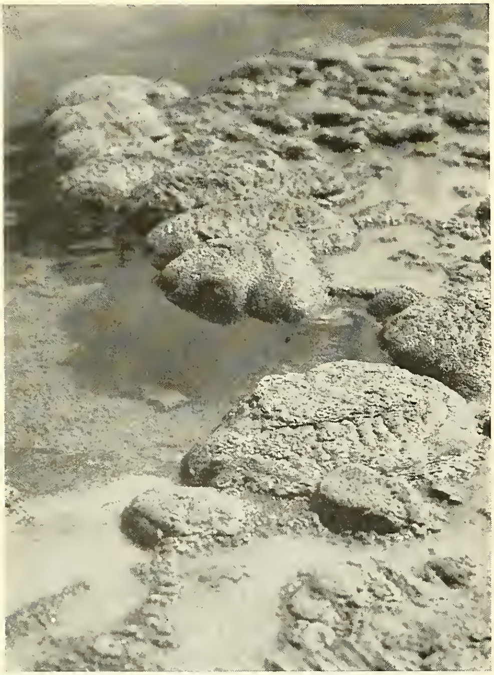




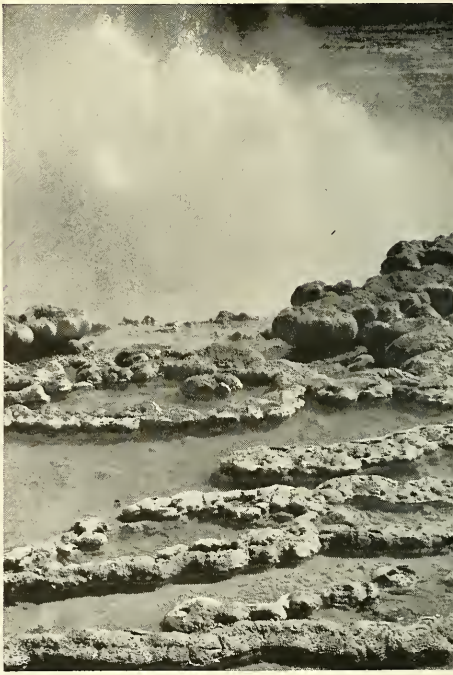
BEFORE QUAKE, mild thermal activity characterized bright clay of the Fountain Paintpot in Lower Geyser Basin, *above*.



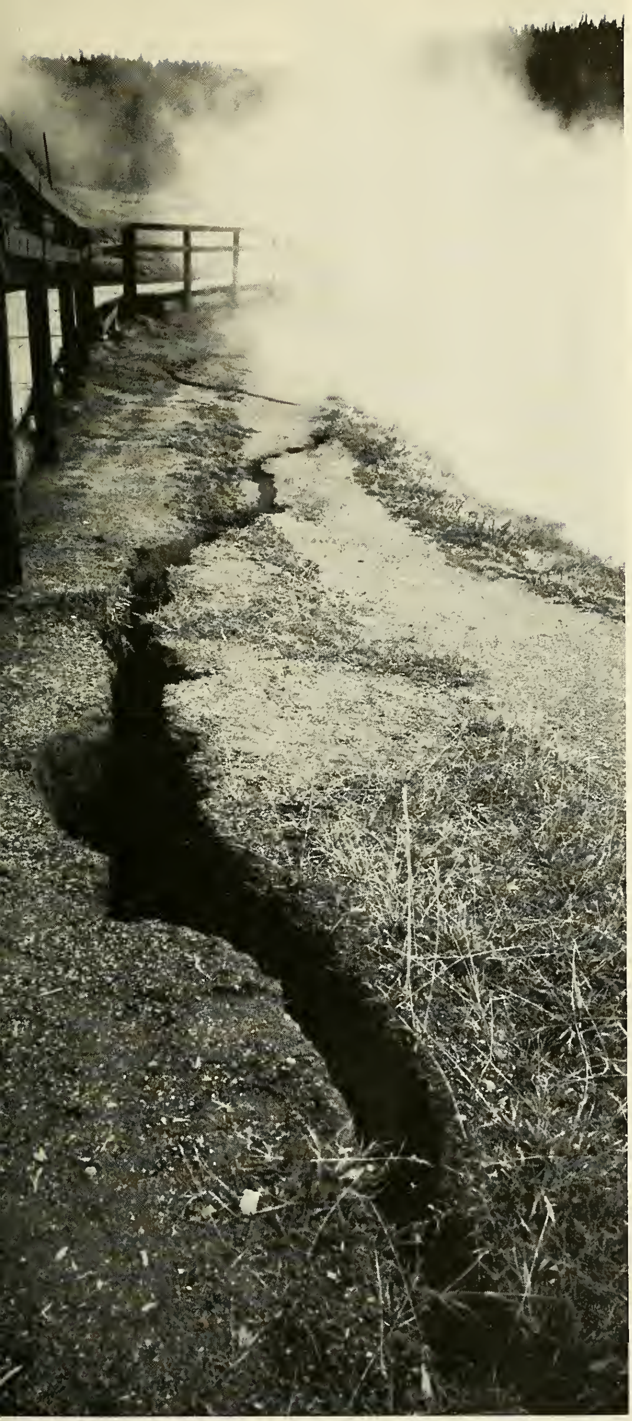
AFTER QUAKE, Paintpot area is greatly enlarged, *ab*
with new fumaroles bubbling and smoking with fierce v



LIMESTONE "BISCUITS" in Sapphire Pool before quake, *above*, were shadowed in clear, blue water that boiled periodically.



TWISTED AND BURNED ROCK mirrors new activity. Pool
erupts violently, *above*, sending clouds of steam skyw



AT FISSURE parallels observation on edge of Firehole Lake, *above.*

Not a local phenomenon, the quake affected over 550,000 square miles.

George D. Marler, the park naturalist who has made a two-year study of the park's thermal basins, told me that in previous eruptions Sapphire had thrown out thirty to fifty tons of water each time. This eruption obviously threw out a good deal more.

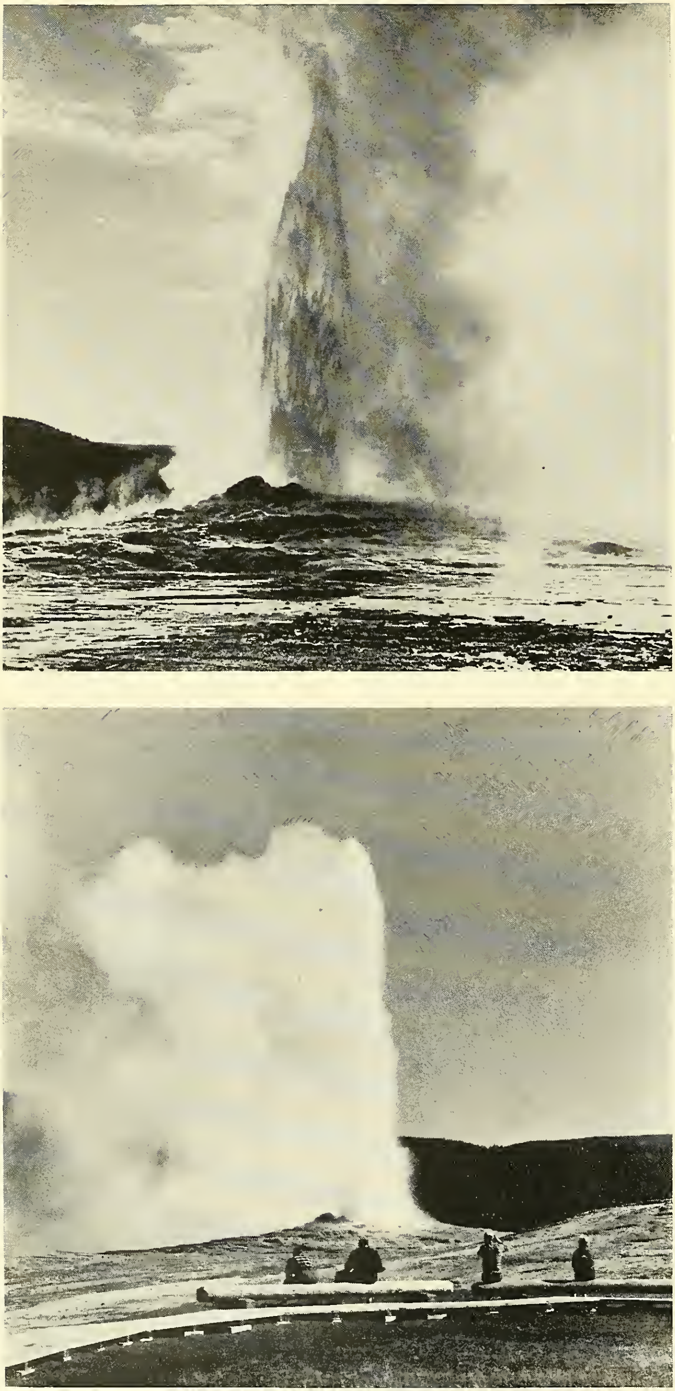
McIntyre and his aides are keeping a chart of the pool's surges and by next spring expect to have wooden walks established at a safe distance for visitors. If Sapphire continues its violent activity, it will be one of the prime attractions of the park.

Another day we joined Ranger Naturalists Robert Alan Mebane and Richard Frisbee on a hike to see what had happened at Sylvan Springs, a thermal basin some distance from the road. After walking for a mile and a half through the woods and across a marshy meadow, we came to a small valley. It was a place, the park men said, that had shown some activity before. Now it looked like an illustration for Dante's Inferno.

On one slope of the valley a small cone belched up gray, steaming mud. Near it was another cone which was filled with boiling, pale-greenish paste. From both sides of the valley sulfurous fumes issued from rock fissures. At one level spot bright-yellow water boiled in a circular pool. Up near the head of the valley, clouds of steam rose from other pools.

As we climbed a ridge, we could see massive clouds rising from the forest. Making our way through the trees, we came upon a violent mud geyser that had not existed before the quake. Large trees had fallen into a hole seventy-five by fifty feet, their roots and limbs tangled and steaming. As the pool rose and fell with a pumping action, the mass of trees went up and down with it. Trees around the pool were covered with gray mud thrown there by previous bursts. It was evident that more trees would topple into the caldron as the heaving action ate away the banks. We named this brand-new, spectacular steamer "The Mudslinger."

Miraculously, all these particular changes in the face of nature occurred without loss of human life, despite the fact that there were 18,000 visitors in the park the night the earth began to move. Superintendent Lemuel A. Garrison attributed this good fortune to two things: the fact that the earthquake occurred late at night when



UNCHANGED BY QUAKE, Old Faithful is still operating on schedule. Photo at top of page was made in 1890's; lower picture shows huge geyser as it is now.

park roads were empty, and the qu and efficient work of the rangers other park personnel in hand frightened visitors, quieting incip panic and clearing a road the morning for the thousands ready flee. There was only one injury woman sprained her ankle during frantic, nocturnal rush to get ou Old Faithful Inn.

"There was no panic," Garr said. "We were a little itchy, bu was a wonderful opportunity to nature at work."

Many persons asleep in cal thought, upon awakening, that the turbance was made by bears ratt the doors in search of food. The of one ranger naturalist insisted he get up and ". . . chase that bea the porch." Soon after the quak became apparent that the bears left along with the people. The ran believe the bears were not driven by the tremors but went away search of people who would give t their accustomed handouts.

"When the workmen were clea a slide that blocked the road at Cascades of the Firehole River found a bear that had been tra under the rocks," McIntyre said. had been under there eight days. A they moved a boulder the fore had them put a tree trunk down in hole. The bear climbed up the and took off. I bet he's running

AT first there was apprehension some of the famous trout stre in the park would be damaged by earthquake. Those originating in Mount Holmes area, including Gardner River, Grayling Creek, Duck Creek, ran opaque-yellow weeks. Now they are clearing up, whether the fish have been affe will not be known until next spr The Madison cleared quickly large trout are visible in its wate

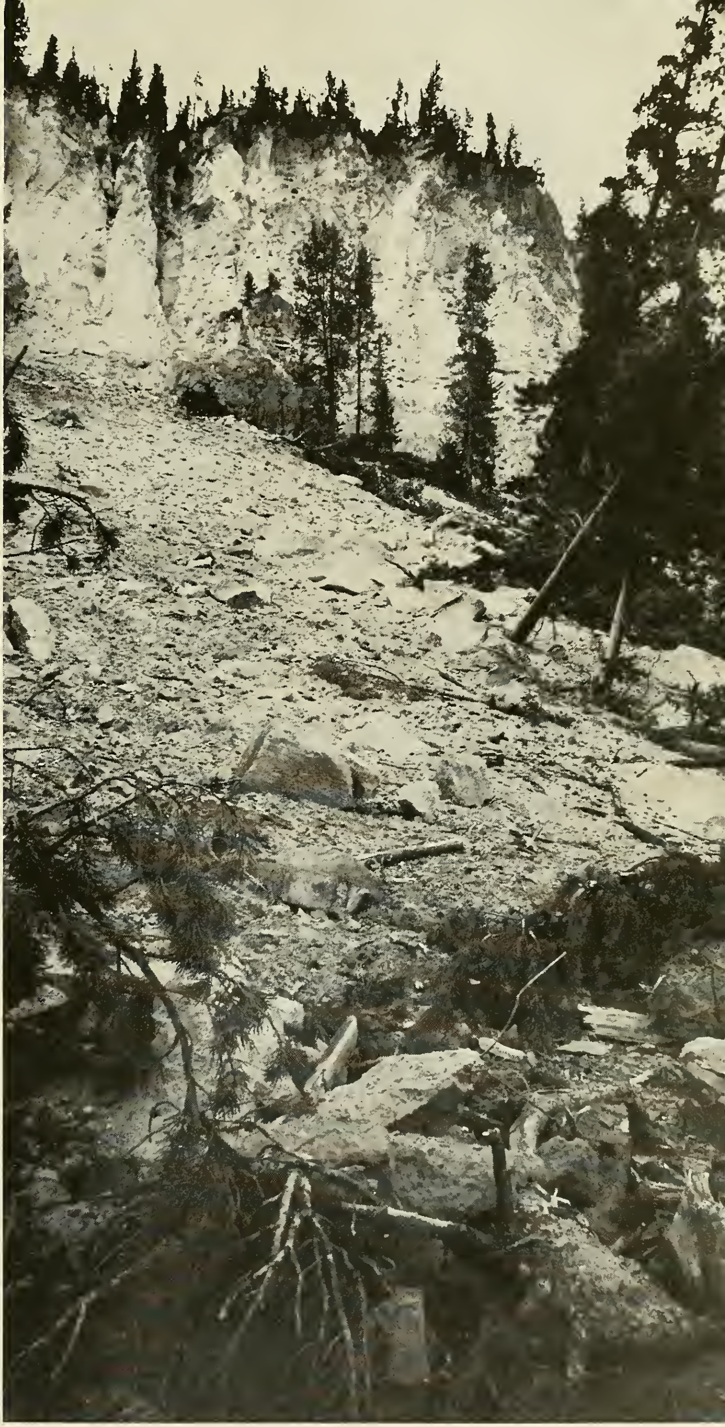
I visited some of the areas w rockslides had felled great num of trees. McIntyre explained that were worried about this huge pil deadwood because insects bree down timber and might cause l infestations of trees still standing said these areas would be watche insect outbreaks. A forester als making a survey of timber dam

Superintendent Garrison and o officials of the National Park Se look upon the earthquake as a c natural disturbance, but one not

s blessings. "After a careful ap-
al we have placed the damage
ads, buildings, and other man-
installations in the park at
)0,000," Garrison said. "We
want to put it too high because
e taxpayers, too. The public ap-
nsion resulting from the quake
ome erroneous reports that came
first have cost us about 200,000
rs who would have come to the
if the earthquake had not oc-
d. On the other hand, it is the
se of our national parks to in-
t nature to the public. The re-
of this earthquake give us plenty
portunities to interpret nature in
f its most violent moods."

CKSLIDES have been cleared
from the roads and highway
es are being made in the inter-
of safety, but beside the roads
scars have been left untouched
at next summer's visitors may
the effects of an earthquake at
and. McIntyre is in charge of a
of ranger naturalists who will
as far into the winter as possible
survey of the changes in thermal
ty. Many of these changes will
bjects for interpretive lectures
nger naturalists.
a result of the thermal studies
new walks for visitors have been
led and the locations of others
eing staked out at safe distances
the enlarged geysers. In some
ces, the walks cannot be located
next spring, when the geysers
ved have ceased their erratic be-
r and settled down into a new
ing routine.
park facilities are now closed
e winter. Next May, when the
reopens, the buildings will have
repaired, the walks through the
al areas will have been rear-
d and the park will be ready for
ess—with added attractions.

XT year's visitors, as well as all
those who wrote and telephoned
after the welfare of Old Faith-
ill find it still in operation at the
old stand. Park Naturalist
r says Old Faithful's imper-
ness results from the fact that
self-contained unit with its own
te fissure reaching down into the
. In any case, those who are
ed about the nation's favorite
r will be relieved to know that
tinues faithful as always.



NEW FACE OF BLUFF near Secret Valley is seen, *above.* Pine forest was scarred by talus from old precipice, ripped off by quake and strewn over foreground.

Unperturbed survivor, American bison stands silhouetted against vapors in vicinity of Old Faithful. Bears and other animals fled region during earthquake, and trout ma been affected, although this will not be known until

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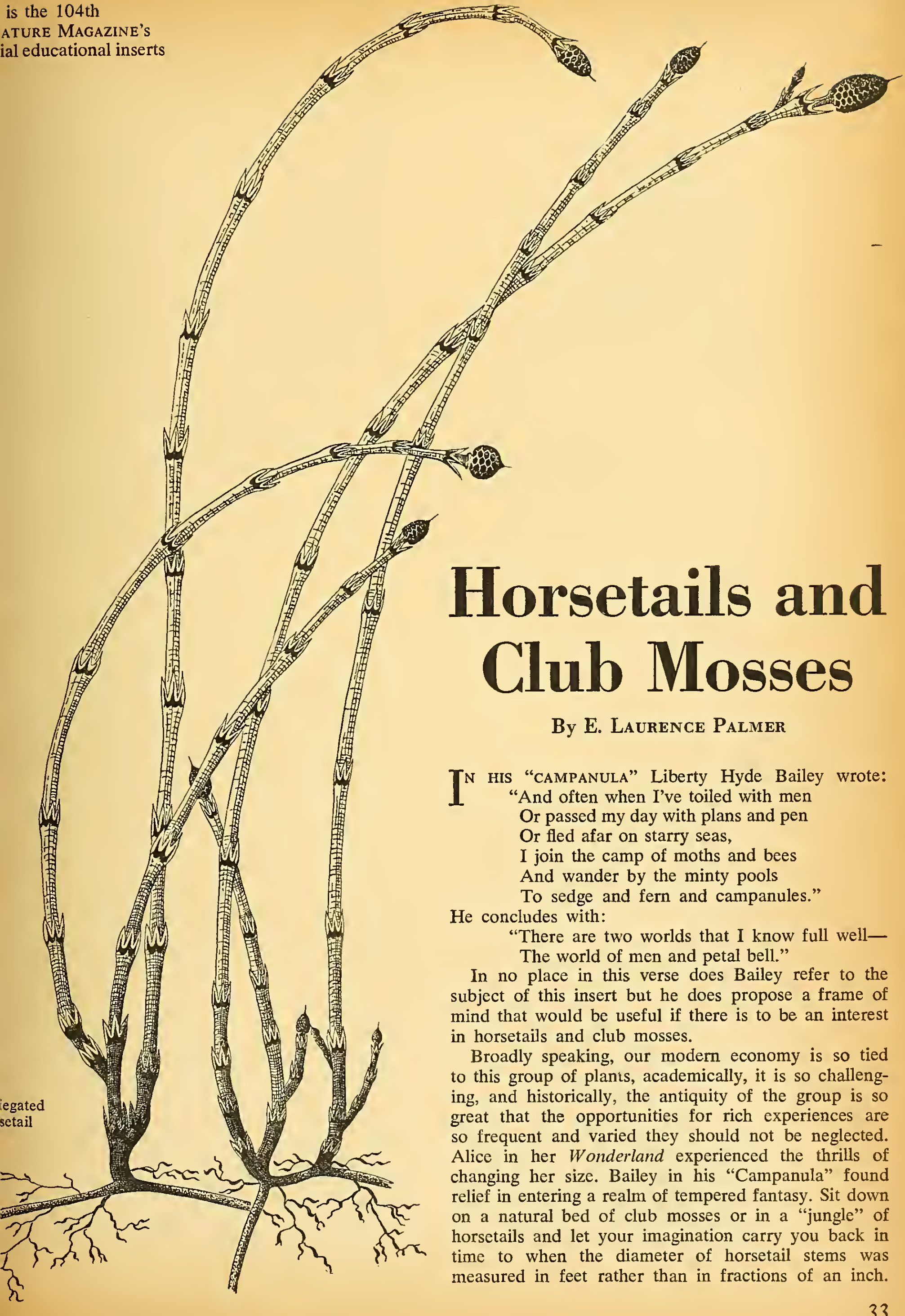


iegated
setail

Horsetails and Club Mosses

By E. Laurence Palmer

In his "Campanula" Liberty Hyde Bailey wrote:

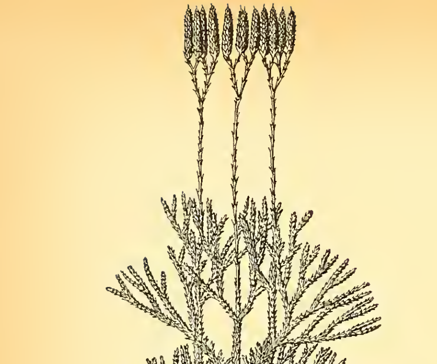
> "And often when I've toiled with men
> Or passed my day with plans and pen
> Or fled afar on starry seas,
> I join the camp of moths and bees
> And wander by the minty pools
> To sedge and fern and campanules."

He concludes with:

> "There are two worlds that I know full well—
> The world of men and petal bell."

In no place in this verse does Bailey refer to the subject of this insert but he does propose a frame of mind that would be useful if there is to be an interest in horsetails and club mosses.

Broadly speaking, our modern economy is so tied to this group of plants, academically, it is so challenging, and historically, the antiquity of the group is so great that the opportunities for rich experiences are so frequent and varied they should not be neglected. Alice in her *Wonderland* experienced the thrills of changing her size. Bailey in his "Campanula" found relief in entering a realm of tempered fantasy. Sit down on a natural bed of club mosses or in a "jungle" of horsetails and let your imagination carry you back in time to when the diameter of horsetail stems was measured in feet rather than in fractions of an inch.



Ground Cedar

This may take you back possibly 300 million years, but when you get there you will find more reality than Alice could ever show you and what you would find has significance in understanding much of the coal and fuels that turn the wheels of our modern industry and give us heat, light, power, everyday gadgets, and probably the very ink used in printing these words.

The horsetails and club mosses belong to a group of plants that includes also the ferns, the quillworts, the water ferns and so on. They are neither "hosses" nor mosses but belong to a historically significant group that lived contemporarily with some of the most phenomenal changes in life that the world has ever seen. The lycopods to which the club mosses belong reached unusual development in the Carboniferous period, when in some areas the dominant tree, Lepidodendron, soared over a hundred feet into the air, supported by trunks whose fossil remains can be seen today in Illinois coal mines where they measure over two feet in diameter. It may seem to be a far cry from a club moss in a modern Christmas wreath to another club moss 300 feet underground in an Illinois coal mine but the story is there. One of my most distressing experiences in World War I was to be forced as a gob at the Great Lakes Training Station to break up the finest specimen I had ever seen of one of these fossils and shovel it into a furnace to heat an unoccupied barracks. Had I known nothing of the story of that stump I might have been happier, but I have never regretted knowing what I was doing in that case.

Many of the readers of this page will have walked through patches of club mosses in the autumn and stirred up great clouds of spore dust. Others may have seen the fleshy stems of field horsetails in spring and noted the clouds of spores that come from them when they are jarred. Given an opportunity, all of these spores are capable of germinating and forming ne parent plants. Obviously, there is not enough roo on the earth for this to happen. If we select a hyp thetical club moss spore we will find that if it falls c suitable territory it may develop into a structure know as a gametophyte. This means that it bears gamet or sex elements. Depending on the species, that gam tophyte may develop into a wrinkled, fleshy stru ture or possibly into a carrot-shaped body. Som times these bodies serve as hosts for rootlike fung which help supply the gametophyte with some of i needs. It may take as much as three years for th spore to merely germinate, and after it gets starte it may take as much as fifteen years for the gam tophyte to reach maturity, so don't form the opinio that you can grow all of these things in a single seaso though there are some species in which this is possibl

It is common in the club mosses for the gametophyt to bear both male and female sex organs on the san plant, and since these can be only a millimeter apa and another plant may be inches, feet, or miles aw it is rather certain what the ancestry of a new gener tion will be. This does not lead to the productio of much variation, and we do not find the variatio comparable to that in organisms in which one pare comes from one side of the earth and the other fro the opposite side, as is eminently possible in ma other plants and in many animals, including ourselve

In the horsetails, it often happens that a spore w develop a gametophyte that bears only organs th produce male sex cells, while another spore may develo a gametophyte that produces only female sex organ Offhand, this might sound promising but examine few horsetail spores under even a low-power micr scope to see what happens. Each spore develops wh looks like a set of springs and these hook on wha ever may be near. The chances are good that eve before the spore leaves the parent plant it has hooke itself to a spore from the same plant. Even though o produces a structure that yields sperms and the oth produces a structure that bears eggs, the chances another plant crashing the family tree are decided limited. Under these circumstances, it is no wond that horsetails of a given species or club mosses given species vary little from generation to generatio or that they have not varied fundamentally since 30 million years ago, when coal was being made. Stud ing our horsetails and club mosses of today may he us to understand those of millions of years ago, ju as studying the ones of millions of years ago ma help us understand those of today. To have a 30 million-year perspective with which to work is helpf in some things but possibly a bit disturbing in other This, however, makes life more interesting.

The horsetails and club mosses of today mo closely resemble the horsetails and club mosses the Carboniferous than the horse of today resembl his ancestors of his antiquity. Horses date back history some fifty million years while the horsetai may go back six times as far. The horses have change more in their fifty million years than have the hors tails in six times as long. In all probability it is mo ely that the horsetails will continue on the earth ıg after the last horse has vanished.

If we go on with our life history of a club moss or rsetail beyond the fertilized-egg stage, we will find plants developing as we watch them. At first, the veloping club moss may resemble a common haircap ss, but what we see in the haircap moss bears true cells and is a gametophyte, while what we see in club moss develops spores, not sex cells, as an d product. The conspicuous part of a club moss then sporophytic while the conspicuous part of a haircap ss is gametophytic. Botanists consider that plants which the sporophyte is the most conspicuous may ll be more recent and higher in the evolutionary ıle than those in which the gametophyte is more dent. For this reason we cannot so logically group mosses with the club mosses as we can group the ıb mosses with the horsetails. Should we elect to the common name moss as a basis for our group- gs, we would find in our category of the mosses Irish ss, which is an alga, reindeer moss, which is a ıgus and an alga, pincushion moss, which is a true ss, Spanish moss, which is a flowering plant, and even ne animals that are known as moss animals and not plants at all. Truly, the word moss suggests a y loose classification, if it represents any at all.

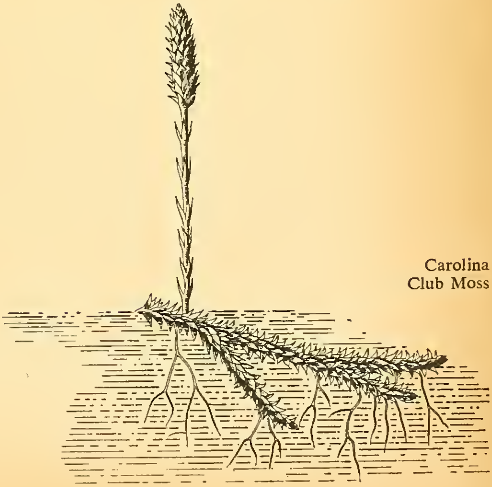
F YOU acquaint yourself with the horsetails and club mosses by any means you may notice that nost universally they live at or close to the surface the earth. You will notice that many of them develop ongly branching structures that form nets or webs the surface of the earth or just beneath it. There is rit in this habit. When you realize how easy it is loose soil to be blown or washed from one place another at the surface, you may get some idea of w valuable these plants are in anchoring soil and eventing wind or water erosion. Remember too that s erosion of which we hear so much may be danger- s, not only because of the soil that is removed t because of the fact that loose soil may pile up ain in a waterway, on a field, or somewhere else ıere it is not wanted. You may have noticed how quently the best stands of horsetail are to be found raw, bare, railroad embankments. Dig down into ch soil as you find there and notice how quickly u find horizontal roots, which serve as an ideal choring net that holds the bank in place, protects the adbed and keeps the soil from filling low spots.

RDINARILY we do not think of the club mosses and horsetails as playing an important role in wild- e management. If you read through the tabular mate- l on the horsetails, you will find that some consti- te a favored food, particularly of muskrats and ıite-tailed deer. Club mosses are not commonly listed being of forage value to wildlife, but opossums have en known to eat them. If they escaped the craw of opossum they might well be about the only living ing with such a record.

A person who has hunted rabbits, pheasants, and nilar small game recognizes that many of these rsetails and club mosses have superior value as cover to which the game can escape. A rabbit that can save its life by dashing into a patch of field horsetail may live to father some more rabbits and keep up the game supply for another year. These days we hear much of the importance of ecology in natural history, that is, of the relation of organisms to their environment. If we examine the ecology of the different species of club mosses and horsetails, we will find that in one form or another they may be found in almost any type of habitat. Some favor dry, exposed areas. Some do well in deep, moist forests. Many like dry sand, while others do well in flooded areas or even out in standing water. The soil or the water in which they grow may be neutral, acid, or alkaline, so, unless man has interfered, these plants may be found in almost any place and, since many are evergreen, at any time of the year.

You may notice when you begin studying horsetails and club mosses more closely that they cannot always survive competition from other plants, even though they can survive soil conditions that are too poor for other plants. Again let us think back that 300 million years and you would find a world in which there were no competitive grasses, a world in which whatever forests there were did not have trees that shed their leaves. It probably was a world in which great areas were bare and completely destitute of plants and, of course, of animals. To these bare areas our horsetails and club mosses could move just as today they occupy bare soil in many places.

THE chances are excellent that if you can develop an interest in these groups in which there are few species you may become something of a local authority on them. The chances are superior that, if you learn to know these plants well, you will have a much better understanding of the natural history of the past than if you depend on dinosaur stamps or models as a source of information. You may get a real feeling for the world as it was 300 million years ago and genuinely appreciative of such plants, whose ancestry extends back through that length of time. Truly the horsetails and club mosses are worth knowing.



Carolina
Club Moss

	Field Horsetail *Equisetum arvense*	**Meadow Horsetail** *Equisetum pratense*	**Wood Horsetail** *Equisetum sylvaticum*	**Marsh Horsetail** *Equisetum palustre*
DESCRIPTION	Vegetative stems to 20-inches high, or decumbent. Crowded or single, annual, green, hollow; two surrounding rows of tubes, which equal number of external ridges—may be 6—14. Outer surface rough. At joints appear sheaths with sharp-pointed teeth. Branches, if present, solid, 3—4 angled, arising in whorls at joints, the lowermost usually being the longest.	Stems of 3 types, the sterile or vegetative, the fertile, and the fertile that may become sterile. Sterile stem may become 2 feet high or more, is unusually slender, pale green to white, with 8—20 grooves, smooth below but rougher above. Branches are whorled, to over 5-inches long, slender, 3-angled. Rootstock is deep, black, wiry, horizontal.	Sterile vegetative stems appear after the fertile stems. Vegetative stems, annual, erect, to 3-feet high, slender, with 12—18 grooves separated by mildly roughened ridges. Lower joints do not bear branches but the upper ones yield whorls of slender, feathery, branched branches, the lowermost up to 6-inches long, horizontal, but drooping at the tips. Stem hollow by over one-half diameter.	Stems may or may n bear cones. Height 2½ feet. Erect, pro trate, or floating, wi 7—10 ridges, with si gle, wide band of por in furrows. Noda sheaths widen abov Central cavity about 1/ stem diameter. Profuse branched or unbranche with lower the longe making somewhat fla topped shape, slende branched and 5-plu angled branches.
RANGE AND RELATIONSHIP	Family Equisetaceae with but one genus, which includes about 25 species and many forms or varieties of which we show nine. This species ranges through northern North America, Europe, and Asia, and ranges south in North America through most of the United States, but usually relatively rare in southern border states or in their southern portions.	Family Equisetaceae. Genetically closely related to field and wood horsetails. Range of this species is decidedly northern, being found from Alaska to Newfoundland, and south to New Brunswick, New York, Iowa, North Dakota, Montana, and southern British Columbia. It is also to be found in Europe and in Asia at about the same latitudes.	Family Equisetaceae. This species close to the field, the meadow, and the marsh horsetails in that each has cones borne on special stems. Like the field, the marsh, and the swamp horsetails, lacks evergreen stems and varies considerably. It is found in Europe, Asia, and America—from Virginia to Nebraska and east of the Rockies, north to the Arctic Circle.	Family Equisetacea This is a species rangi from Alaska south Oregon and around th globe at about that lat tude. About a doze forms recognized, base largely on variation vegatative types inclu ing branching, coars ness, stiffness, and a rangement. Unite States range exten south to California, Ill nois, Vermont, an Maine.
REPRODUCTION	Fruiting stems appear early spring before sterile stems, are to 8-inches high, unbranched, to 1/3-inch thick. Cone at top of stem, closely crowded spore-bearing structures, which bear spores in marginal structures, each of which is wrapped in 6 long hairs, which act like springs. True sexual stage develops from spores into green structure, bearing both eggs and sperms.	Spore-bearing cones at the end of stems, which may not survive spore-bearing, and which bear unusually large sheaths, the cones being borne at the end of unusually long stalks above the uppermost joint. Other stems with narrower sheaths may bear cones at the tips and, at the same time, a few whorls of weak branches, which may develop after cones and spores are shed.	Fertile stems are to 8-inches tall, erect, at first flesh-colored, with terminal cone, which is shed early, after which stem develops much as those that are sterile. Small whorls of branches appear with the cone or before, these being smaller than in the sterile stems and less profusely branched. Cone withers early and drops away after spores are shed in May and June.	Cone is borne at end short portion abov branched stem or som times at end of branch as well, but these a smaller than the term nal one, which may to 1-inch long. The "sporophylls" are par of the strobile and be "sporangia," which be the spores, which a wind-borne and develo into "gametophyte stage.
ECOLOGY	This species varies greatly in form and habitat, favoring stream banks usually rich in sand, but may be common in woodlands, meadows, roadsides, railroad embankments, but probably is most common in damp, sandy, somewhat shaded loose soils and once established may persist. Grows in sun or in shade, in pure stands or mixed with other plants.	This species is known by some as the "shade horsetail." It may be found along shady stream banks in neutral or rich soils, on rocky exposures or stream borders, but usually in the shade. This species is found near water but does not flourish in water. In the sterile stage, the horizontal branches may droop close to the main stem before leveling off to the horizontal.	Found in and around water of wet woodlands or swamps if sun can penetrate, favors slightly acid soils that are rich. The deeply buried rootstock bears reproductive tubers and buds. The tubers are larger and more oval than are those of the field horsetail and the smaller buds may develop next year into fertile stems.	Highly variable in hab tat and while it favo flooded areas it is n too common in water. Found mostly alon margins of ponds, col streams, woode swamps, flooded land and similar areas, rathe commonly in the shad It is not a commo horsetail and does n appear in pure stands do so many species become general in a par ticular region.
ECONOMY	Primary value of this species probably that of being a soil anchor in loose soils with the deep rootstocks playing important role.	Probably of no great economic importance, but of interest to botanists because of stem variations, as described above.	Of no economic importance, but, by many considered one of the most beautiful of all non-flowering plants.	This may be attractiv because of its feather appearance but its mois ture requirements ar such that it is not likel as a popular ornament species.

wamp Horsetail *quisetum fluviatile*	Smooth Horsetail or Scouring Rush *Equisetum laevigatum*	Rough Scouring Rush or Horsetail *Equisetum hyemale*	Northern Scouring Rush *Equisetum variegatum*	Sedgelike or Dwarf Scouring Rush *Equisetum scirpoides*
ght to 3 feet. Sterile is may be branched a portion of the th, while cone-bear- fertile stems may l be unbranched. ns about ¼-inch k, annual, smooth. low, with cavities g 4/5 of stem, about dges. Green sheaths oints, with sharp- ted, dark brown close to stem.	Fertile and sterile stems not differentiated. Stems commonly annual, to over 3-feet tall and to ¼-inch thick at base, usually unbranched, relatively smooth, with about 18 rounded ridges. Sheaths at joints to 1/3-inch wide, spreading upward to form funnel, dark banded, and with white-margined, sharply pointed teeth. Rootstock branching.	Evergreen stems, to 8-feet tall, unbranched, slender, dark green, with rough surface, arising in clusters, with about 30 broad ridges with conspicuous rough bands of silica, hollow, with central cavity about 2/3 the stem diameter. Sheaths at joints nearly cylindrical, tight, with sharply pointed teeth that soon wither. Rootstocks branch.	Evergreen, perennial, uncommonly branched, to over 15-inches tall, with equal length for sterile and cone-bearing stems, dark green but with conspicuous black and white sheaths, sheaths at joints persistent, spreading upward. Ridges, 5–12, rough or smooth. Leaves 4-angled. Rootstock horizontal, slender, black, shallowly buried.	Stems evergreen, to about 10-inches long, prostrate, or curving upward, not commonly straight, slender, arising in tufts — but, if branched, then at very base—green, solid, about 1/25-inch thick. Leaves at joints, 3, not connected, with persistent broad, black, white-bordered teeth, apparently 4-keeled, becoming dark brown to black.
ily Equisetaceae. forms of the spe- are recognized, base tly on branching, seness, and nature e cones. This spe- ranges through the sonian and Transi- Zones of North rica and of Europe. found from Alaska abrador and south regon, Wyoming, raska, Virginia. It originally described innaeus.	Family Equisetaceae. Closely related to rough horsetail, in which the sheaths are nearly as long as broad, and cylindrical, while in smooth horsetail they are much longer than broad, and funnel-shaped. It is found in Upper Sonoran zone, ranging from British Columbia through Minnesota to Ontario; south to New Jersey, Missouri, Texas, and southern California.	Family Equisetaceae. Rather closely resembles smooth horsetail, which see for differences. The species is found in Europe and Asia and in North America from Alaska to Nova Scotia and south to California, Texas, and Georgia with a number of distinct varieties in the eastern and western part of the range in North America.	Family Equisetaceae. With three, well-established varieties and possibly some hybrids making final identification difficult, particularly as authorities seem to disagree. This species in different forms ranges from Alaska to Labrador and south to Oregon, Wyoming, and Connecticut; and into Greenland, Europe, and Asia.	Family Equisetaceae. Our smallest living horsetail, found in northern North America, Europe, and Asia with American range from Alaska to Labrador and south to Washington, Montana, Michigan, Illinois, and Pennsylvania. Single plant may produce to 100 stems from a more or less common base. No commonly accepted forms or varieties seem to be established.
s may be borne on rate stems, which or may not branch. s are about 1-inch and about ½ as and may terminate nain branches or in cases the second- branches. Cones relatively long sup- ng base and when is done, drop off.	Fruiting cone is terminal, appearing May-July, either blunt at tip or with small pointed tip. Spores are shed and develop into green structures that are inconspicuous and bear either male or female organs, the products of which unite and from which develops the conspicuous spore-bearing plant.	Cones appear at tips of stems from June through August, with one cone to a tip, to over 1-inch long, blunt but in some varieties with a short sharp tip. For details of sexual reproduction see preceding columns. Because of its characteristics, the plant is known as scrub-grass, shave-grass, sunbright, referring to use of stems as abrasives for many uses.	Cones are usually under ½ inch long, slightly thicker than the supporting stems, in general egg-shaped but terminated by a rather sharp point. When the spores are shed the bare axis, which supported the cases, may persist, giving these stems a distinctive end (strongly apiculate). Since in the northern part of the range the stems may not survive the winter.	Cones are small, black, terminal, stemless, with sharp-pointed tips, appearing as snow disappears and beginning spore-shedding when snow vanishes, continuing shedding until late summer. Reproduction by rootstock division probably surer than by spores.
ally submerged s begin early devel- ent before ice melts green stems ringed black-toothed aths may show in r before land plants v much develop- t. In southern part nge, cones are pro- d about the last of , the spores are , and cones that are t are shed. The spe- is known as water etail, mud horsetail, lock pipes.	Favors damp areas, on sterile sand or equally sterile clay as well as on rich soils of meadows and prairies. The spores bear twisting hairs, which interlock with those of other spores, making a mass in horsetails that guarantees that even though spores develop into structures bearing male or female units they shall be close together and fertilization may be assured.	May favor relatively dry banks or may do well on moist slopes either in the shade or sun, but most commonly probably in the shade. Because of size and relative abundance this plant is well known. Burned, the hollow jointed stems may explode with a popping noise, which Indian medicine men believe may put new vigor into those who are ill.	Found in zone north of 42nd parallel to beyond Arctic Circle with records in all of the states bordering Canada. Found in areas rich in lime, often following lime outcroppings, but may be found in woodlands, meadows, beaches, sandy slopes, and bog margins still favoring lime deposits, but not always demanding such situations.	Sporadically common in evergreen woodlands, swamps, springy banks, borders of ponds, brooks, and waterways, and even on wet ledges or gorges clinging to rock crevices but may appear in open fields upon occasion. Not so commonly conspicuous in pure stands as are some other horsetails and may be almost wholly buried in loose soil and mud of environment.
ably of no major omic importance nay serve to anchor mud of shorelines serve slight role in l control. Favored of deer, muskrat.	Of no great economic importance but really interesting to botanists and probably of some value as soil anchors.	Some have recommended using the ashes of burned, rough scouring rush as a polishing powder, but this is hardly of great importance.	Probably of no specific economic importance either to man or to wildlife and of no great importance in ecology.	Probably of little or no economic importance and not listed as food of wildlife, though they may very well be eaten by many forms.

	Common or Staghorn Club Moss *Lycopodium clavatum*	Fir Club Moss *Lycopodium selago*	Shining Club Moss *Lycopodium lucidulum*	Bog Club Moss *Lycopodium inundatu*
DESCRIPTION	Horizontal stems trail at the surface of the ground, bearing roots at intervals and branching or sprawling over adjacent plants. Ranked in 10 lines, spreading upward, sideways, or downward. Stems are repeatedly 2-branched and covered with leaves, which may persist many years. Horizontal branches may be many yards long.	Horizontal stems usually under 1-inch long, bearing tufted vertical stems, which are to 10-inches long, repeatedly 2-forked, compacted, or loosely crowded—including leaves, may be to ½-inch thick. Leaves to 1/3-inch long, densely crowded, dull yellow-green, not showing conspicuous seasonal differences in length.	Basic horizontal stem short and often lost, but produces stems which fork 2 or more times, may bear roots in basal portion, curve upward from portion that may be covered with dead leaves. Leaves crowded on stem; are to ½-inch long, shiny dark green, with slightly toothed margins, with shorter leaves marking end of year's growth.	Stems horizontal erect or ascending, d pending on lateral su port. The horizont stems creep closely the surface or intertwi with other plants lil sphagnum, are cover closely with narrow aw shaped leaves, whic are likely to twist u ward even from the u derside, which ma appear to be flattene are to 8-inches long.
RANGE AND RELATIONSHIP	Family Lycopodiaceae. Differs from closely related stiff club moss, *Lycopodium annotinum*, most conspicuously in that stemmed portion bearing cones is not so closely leaved as in the bristly species. This species is found in Europe and in Asia, and in North America ranges from Alaska to Newfoundland south to Oregon and North Carolina.	Family Lycopodiaceae. Represented by single genus *Lycopodium*, which dates far back into geologic time. At least 3 varieties of this species recognized. Range of this species, Alaska to Greenland, and south in higher elevations to Washington and North Carolina. Also found in New Zealand, Australia, Europe, Asia, and Antarctica.	Family Lycopodiaceae. This species is found in Asia as well as in North America, where it ranges from Newfoundland to South Carolina and west to Tennessee and Washington in one form or another, and is reported from Japan, China, and the Himalayan mountains. It does not seem to be found in Europe. By many it is believed to intergrade with the fir club moss.	Family Lycopodiacea This is another sma club moss, in this ca some fruiting plant measuring less than inches long. It is foun in at least three form is known from Euro and Asia and ranges North America fro Newfoundland Alaska and south New Jersey (in th mountains to Virginia Ohio, and Oregon. O found in southern U.
REPRODUCTION	Cones or spore-bearing portion of the stem, separated from the densely leaved area by a sparsely leaved portion, which branches unevenly into a number of forks or is unbranched. Fertile portion is to over 3-inches long, pale yellow-brown, with the scales sharply hair-tipped and tooth-margined. Spore cases ripen from midsummer to late autumn.	Spore cases are borne at base of upper leaves, exclusive of those of the year's development, and may persist many years, are generally hidden by upcurving leaves. Spores develop into flat structures, which bear sex organs, and fertilized egg develops spore-bearing plant. This gametophyte stage most inconspicuous. Asexual structures may be borne by upper leaves.	Spore cases orange to yellow, borne at axils up upper leaves, but not to tip, shed spores abundantly from July through September. Major reproduction is by division of plant body due to growth and forking. Upper leaves may also bear little bulbs at bases, which may break loose with the attached leaf and form new plant.	Fruiting stems tend an erect or semi-ere position with the fru ing portion at the tip a pearing to be bushy a to 5-inches long. T leaves of the fruiti portion are somewh longer than the others-green, sharp-pointe with rounded base b narrow connection stem. Spore cases sh spores in late autumn.
ECOLOGY	This is a cosmopolitan species found in a variety of habitats but common on forest floor where trees are not abundant, or in open where there is usually some shade and where it may form great mats ideal for outdoor sleeping or for making mattress filling. Because of its abundance, it is probably as well known as any of the club mosses.	Found in damp, cool, shaded ledges and protected areas but a variety, *patens*, may survive drier areas. Spore cases may appear to be borne in annual zones, and leaves of this species may appear to be more uniform and crowded.	Favors deeply shaded areas over rocks and acid soil, and may crowd stream banks closely in gorges, often overhanging streams. The plants do not do well in warm areas but are exceptionally hardy and may survive for months after being pulled from original site if the water supply is restored. Do well in evergreen woodlands.	As name implies, this essentially a bog pla It may be consider relatively rare in th United States and it extremely rare aw from water. If und turbed, it may form rings due to radiati growth from an initi plant and the decay the basic plant, while t growing tips spread o radially.
ECONOMY	This species produces lycopodium powder in great quantities from Russia, Sweden, and mid-Europe. This was formerly used in flashlight powders but is now used to coat pills to prevent them from sticking and has been used in high-class face powders to absorb moisture. Plants make superior Christmas wreaths.	Medicinal uses once recognized are not now considered valid but it was used as a cathartic, an emetic, in ointments as counterirritant, in making intoxicants, as ingredients for bringing good luck, to destroy vermin on cattle, for fixing color in woolen goods, and for dyeing, and with these long-standing records the plant can claim some interest on our part.	No particular economic importance is recognized, though it may share the reputation of the fir club moss. This is and should be a popular terrarium plant for indoor use, since it is hardy, beautiful, relatively slow-growing (to 1 inch a year), and because it illustrates reproduction by vegetative division, by spores, and by special asexual bulblets.	There seems to be sound economic use this plant and even th fairy-ring developme of the horizontal ster does not seem to ha aroused any major i terest among those w relish such reference The bushy fruiting po tion is less develop than in the closely lated foxtail club mos *Lycopodium alopec roides.*

REE CLUB MOSS *podium obscurum*	**GROUND CEDAR, CREEPING JENNY** *Lycopodium complanatum*	**GROUND CEDAR OR GROUND PINE** *Lycopodium tristachyum*	**STIFF, BRISTLY, OR INTERRUPTED CLUB MOSS** *Lycopodium annotinum*	**CAROLINA CLUB MOSS** *Lycopodium carolinianum*
izontal stems are ed deeply in the soil, ch freely, bear roots intervals, and are ngly covered with yellow, scalelike s. These horizontal s lack the length of that sprawl at or the surface as in r species. Since e buried portions the roots, the plants ifficult to transplant.	Horizontal stem only slightly buried at the surface of the soil, branching freely and irregularly, bearing penetrating roots and erect stems that are most frequently seen. Erect stems branch freely into 2's repeatedly but have a distinctly flattened appearance. Erect stems may stand to 15-inches high and be covered with appressed leaves.	Horizontal stems are buried deeply in the soil, bear few if any leaves, branch freely. The vertical stems arise from the horizontal branch repeatedly into 2's, or produce one branch that produces another tier of branches and this may continue, forming what looks like a series of loose open funnels, one on top of the other.	Horizontal stems trailing, to over 6-feet long, bearing roots at joints or irregularly, with leaves not abundant, usually buried in debris. Vertical stems arise from the horizontal, usually singly, but soon branch and rebranch, and may reach a height of over 1 foot. Leaves of vertical stems obscurely indicate year's growth.	Sterile stems cling closely to ground, bear roots, are to about 4-inches long, covered with leaves, each about 1/3-inch long, sharply pointed with spreading tips, entire, in 6 ranks, with those of the upper broad and the lower 4 narrow and scalelike. The stem bearing the cone is erect with leaves in whorls, one stem per plant.
ily Lycopodiaceae. is one of a group of mosses in which the branches are either ke or treelike. The non name tree club indicates the re- lance of this species tree form. It ranges Alaska to New- dland and south to ington, Montana, essee, and Georgia.	Family Lycopodiaceae. This species is probably most closely related to the ground cedar, *Lycopodium tristachyum.* The fact that reputable books give the name ground pine to both may be taken as evidence. This species is found in Europe and Asia, in North America from Alaska to Labrador, ranging south in some forms into South America and Asia.	Family Lycopodiaceae. This species is found in Europe and Asia and in North America, ranges through Newfoundland and Quebec to northern Alberta, and south to North Carolina and Tennessee. Some authors consider it a variety of *Lycopodium complanatum* but it probably is entitled to entity. Its rather limited range is worthy of notice.	Family Lycopodiaceae. Closely related to common club moss, *L. clavatum,* from which it differs by having fruiting portion of upright stem not separated from leaf-bearing portion. This species in one form or another, ranges through Europe and Asia; is also found in North America from Alaska to Labrador and south to Washington, Michigan, and Virginia.	Family Lycopodiaceae. This is probably our smallest club moss and if found in fruit is easily recognized. It clings so closely to the ground it is pulled with difficulty. This species is found in the United States from New Jersey to Florida but near the coast. Possibly invalid reports indicate it is not found in Europe but is found in parts of Asia.
s are borne at tips rect branches in dance, are cylindri- o 2-inches long and w. Each leaf is al- round, sharply ted at free end, what translucent, nearly overlapping eighbor. The spore s are yellow, ded, and bean- d. Mature about mber, but may per- ntil November.	The fruiting cones are to 2½ inches long on stems to 3-inches long and borne in groups of 1—4. Leaves of cones are yellow and cases spherical. Spores are shed from July through September. Spores germinate into deeply buffed crown-bearing tuberous structure, which develops a structure that bears male and female sex organs.	Erect stems grow to over 1 foot high and are definitely treelike in their general appearance, with the lower branches the broader and the upper forming a flat-topped structure above which rise the stems that terminate into twice-branched stems that bear about 4 cones that look like some candle-holders.	Fruiting portion of upright stem continuous with the leaf-bearing portion, with transition often obscure, grows to 1½-inch long, yellowish, with kidney-shaped spore case at base of each leaf, bearing pale yellow spores that terminate in an abrupt point. There is little difference between the stem leaves and the cone leaves but for the spore cases.	Erect fruiting branch may be to 10-inches high but is usually much less and is unbranched. The terminal cone is composed of crowded spore-case-bearing leaves, whose tips may spread outward, yellowish green, with each leaf pointed at tip and narrow-lipped at base. In South, cones may be to 4 or more inches long, while in the North they are commonly shorter.
d for the most part elatively sparse pings, usually near or marshes in led areas. It appar- requires an acid The two chiefly re- ized varieties differ at one has the cross n of erect stem and -sided leaves while ther shows a flat- structure of two primarily.	Sex stages of the different club mosses include a vertical tuber as in the species, a top-shaped structure as in *L. clavatum* and wrinkled, partially flattened structures as in *L. clavatum* and *L. annotinum.* Some of these are supported by fungi that act as roots, while others are independent. This species is found in sandy, grassy types of habitat, and in evergreen woodlands.	This species is found usually in dry sandy woods or fields where the soil is acid. The color is a most attractive dark blue—green, which increases popularity of plant and encourages flower-collectors to take it as a specimen but its underground system is so great that transplanting is difficult and usually unsuccessful.	This is a rather northern species and favors cool, shaded, sparsely wooded areas or may almost exclusively cover the forest floor in some spots. The common names of stiff and bristly club moss are ably descriptive, and common name interrupted club moss refers to the sometimes obscure divisions between the growth of the different years.	Found in a great variety of types of habitat from open, grassy, sandy or moist areas to wooded bogs and pine barrens in the shade. No matter how extensive the sprawling horizontal part of the plant may be, there seems to be but a single, erect, fruiting branch per plant. Fruit stalk rises from older portion of branching horizontal portion.
ence that this plant teresting may be d in the many com- names it has ac- ed. These include nd pine, bunch ev- en, *petits pins,* and s. Other club mos- ave common names ring to cedars, firs, ther trees but none re appropriate than ground pine for species, though of se it is not a pine at	This is a common species used as Christmas greens and therefore has disappeared from some areas near large communities. Good conservation practices should discourage the use of these plants for these purposes because they serve a role in soil anchorage where they grow, and they have a remarkable ancestry, which is only partly understood.	This species has no great economic importance as a great spore-producing plant that could yield a commercial product economically. Its greatest claim is its natural beauty as seen in its natural habitat and it is hoped that it will not he disturbed anywhere unnecessarily.	Within its range most people use this plant for Christmas wreaths but not so commonly as other species. Its long horizontal stems with branches lend it ably to such use, but its easily-pulled-up, long stem also lends to easy destruction of the plant. The plant's best protection may be that its range is mostly north of centers of population.	Not sufficiently abundant or so easily harvested as some other club mosses as to be of value in wreath-making, and apparently not well known enough by those who ascribed medicinal and other values to other forms to have won similar recognition. This leaves the plant to the mercies of the botanists who find it interesting.

nature IN THE SCHOOL

There was a time "pony tails" were a major interest in schoolrooms. There was also a time when horsetails represented the dominant population of much of the earth. There was a time when it was felt that children should do only what they wanted to do in school. There may come a time when disciplinary situations may return the rod to popularity. It may seem far-fetched, but we propose here to suggest that horsetails and club mosses, properly handled, may bring a new activity into school that would cut down on disciplinary difficulties because of the interest they create, and would provide a sounder basic science than is now gotten from the average school science text; or we suggest that our science texts be checked more carefully with basic academic sources. As a general thing, the major natural history museums of the country may be of great assistance here. It is hoped that the section immediately preceding this section may be useful in developing a new school interest.

No one can deny that young folks have a consuming interest in dinosaurs and the environment and times in which they lived. But dinosaurs are no more, though we do have some diminutive representatives of the reptile group. Many dinosaurs lived in areas in which the landscape boasted enormous horsetails and club mosses, and their diminutive relatives may be found at some time of the year in almost any part of the country —in wastelands, marshlands, sandy country, or lush meadows and woodlands. Why not set the students the task of trying to represent the past in which their beloved dinosaurs lived, by beginning to understand local plants related to those that supported the popular reptiles by providing the food sources?

This insert introduces you to eighteen cosmopolitan plants of this group, some of which may be found at almost any open country spot in the continent. At Christmas time, many of these plants are brought into the schools as wreaths and some old wreaths may be found in attics, storerooms, in schools, or even in florist shops. If the students decide that they wish to make their own collections, a beginning in conservation education may be made by asking that they use reason, and collect only small amounts of material so that local supplies may not be diminished.

Many museums have for sale small plastic dinosaurs. One of these set up in a terrarium in which small horsetails and club mosses may have been established, may have effective educational possibilities and may create a better "atmosphere" for appreciating the animals than is provided by the showcase or laboratory shelf.

If the above is attempted it may become evident that it is not always easy to transplant club mosses and horsetails successfully. The little Tree Club Moss, for example, would be exactly the kind of plant one might wish to have in a terrarium. However, this species has a deeply buried horizontal stem on which the vertical stems depend, and without this established, the desired plants may not survive. It would be much like picking off an apple twig and expecting the twig to survive if it were stuck in the ground. If you will look over with some care the "write-ups" in the insert, you shoul find a few species that may be available locally, unde conditions that you may duplicate in your terrarium Be sure not to try growing a plant that normally grow three feet tall in your terrarium that is less than on foot high. Unnecessary difficulties may arise if yo do so, and the plant will certainly suffer.

In rapid review of the preceding text let's remin teachers that any study of coal resources in geography or of conservation should be enriched by studyin plants closely related to those which formed coal, an this may be of tremendous economic importanc throughout the country.

The study in geography of the coal resources of th world may help one appreciate the changing climate of the world by remembering that in all probability clu mosses and horsetails have prospered in the sam climates they now find suitable, and that, if we fin coal in remote sections of the earth, we can hav reasonable assurance that at one time the climate i those places was about the same kind of climate as tha in which these plants now live.

Some schools may have youngsters who would lik to become leaders in some one field. If there are such why not start with a plant group that has relativel few local representatives? Then a good outdoor studen may find that he is the authority for the school or th county on this group or a portion of the group. If h wants a real challenge let him set out to try to find th sex stages of the club mosses of the county or of an club moss for that matter, preserving them in alcoho and making an exhibit that has real scientific merit.

Should a school be interested in trying to raise som of these plants, it would be a sound plan to assig to some student who may be seeking recognition in a science-talent contest the job of getting samples of eac of the units in a complete life history of any club moss horsetail, or fern. If any student wishes to try this for that matter, it might be well to try as a starte sowing the spores of different plants of the group o different labeled pieces of filter paper placed under a jar where they may remain moist, and having for display and explanation some gametophytes of some o these plants. This may sound more difficult than it is unless, of course, you try to raise all the kinds to be found. Specialization will produce better results.

If you wish to study these plants by "playing" with a compound microscope, few things will provide more interest in the plant group than watching what happens when a bunch of horsetail spores are sprinkled on a moist surface. If you can get some student who can learn how to make some particular one of these apparently identical spores produce male plants while others produce female plants he may be able to earn a doctor's degree and come back and tell the school what is what.

Dr. E. Laurence Palmer, for many years director of Nature Magazine's educational program, continues his special inserts in the pages of the combined magazines.

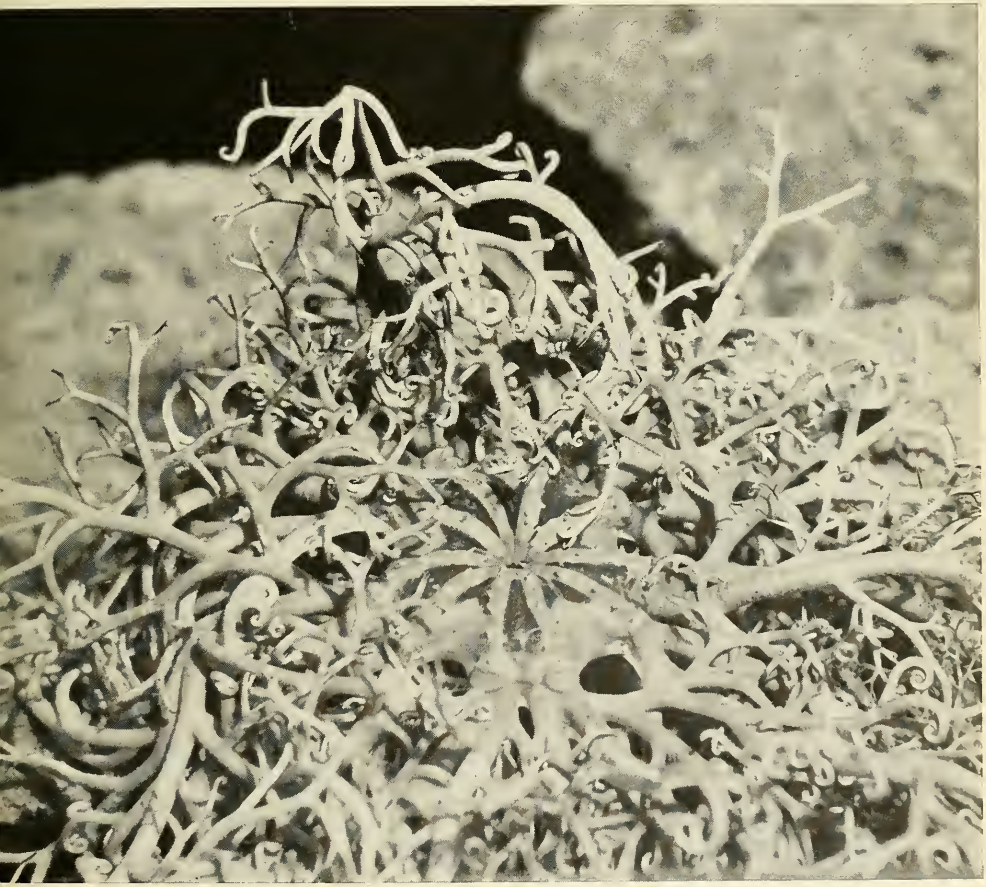
EA BED AMBUSH

otic echinoderm has odd trapping method

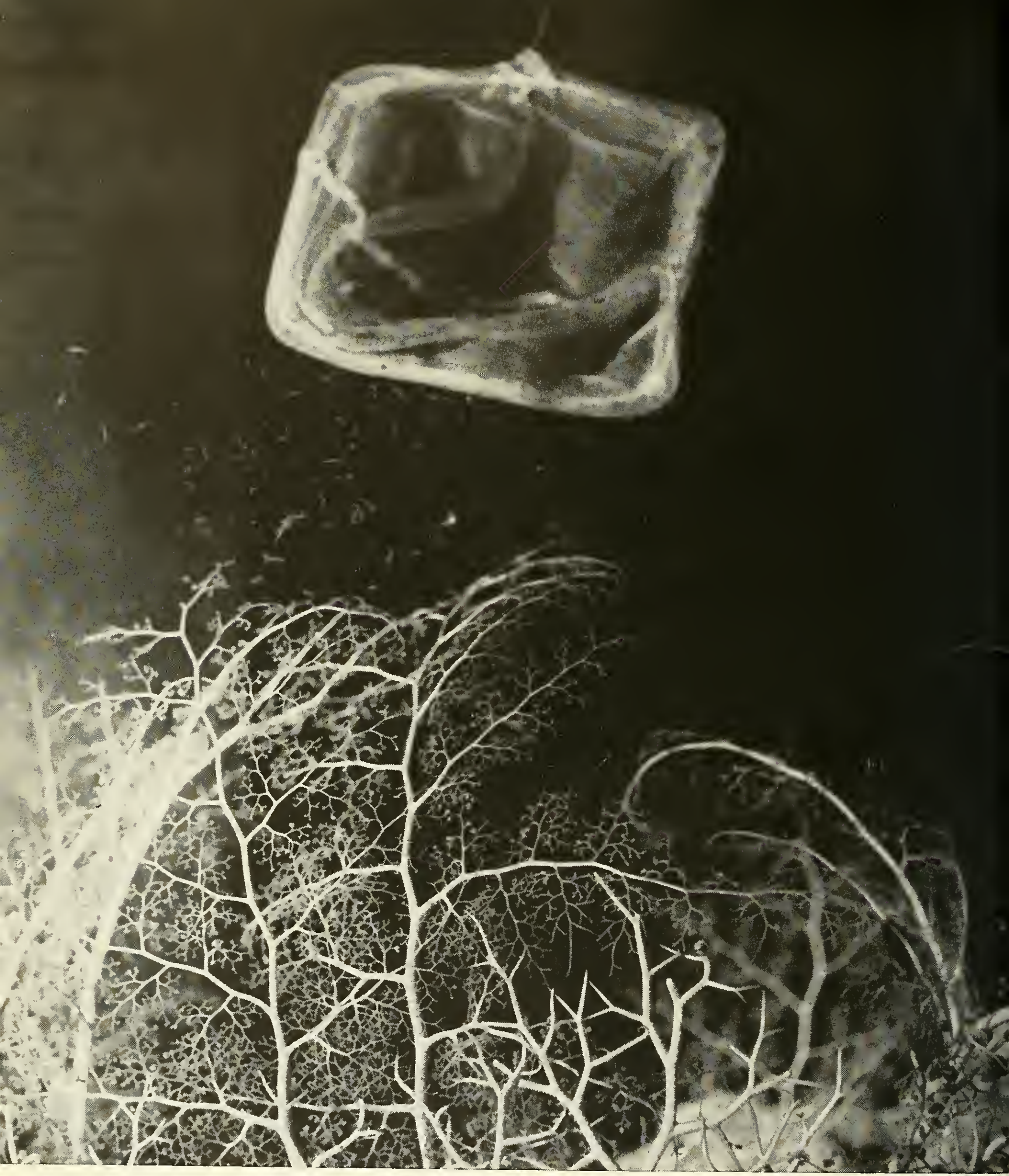
By James W. Atz

IE CONGLOMERATION of ranches on these pages is not queer leafless plant or a mass od vessels gone mad. It is a well- ized animal of definite architec- ınd specialized behavior. This is ket star—an unusual type of brit- ar and a distant relative of the nown starfish. Like the starfish, sists of a centrally located body five radiating arms, but unlike tarfish, each arm divides and subdivides again and again, ending in myriads of fine, orange-brown branches. Basket stars live at the bottom of the sea, sometimes at considerable depths, and often grouped together. This specimen was collected in the Bahamas by Dr. Carleton Ray of the New York Aquarium, where it was put on exhibition and photographed. When fully extended, it was about eighteen inches high, with a basal radius of about six inches.

Basket star, clinging to rock in New York Aquarium, has no stinging cells.



bbed supporting ribs of animal are shown at center, e. From the underside of this central disc radiate five arms that divide and re-divide to form what appears to be a tangled mass of branches. These contract when stimulated.

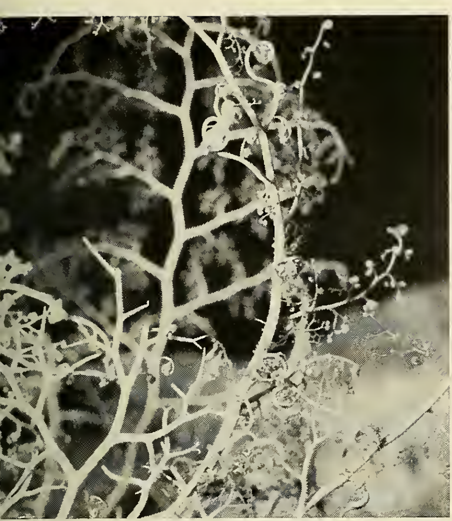


PREY IS ROLLED UP IN THE BASKET STAR'S LACY LIM

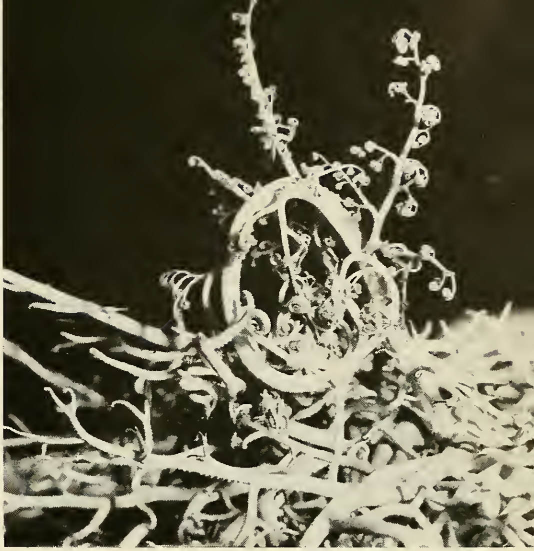
In nature, basket stars feed on copepods (tiny relatives of the crab and lobster) and other miniscule animals that swim or float in the sea. The specimen at the New York Aquarium was fed brine shrimp. These were put into its tank daily, or whenever the basket star expanded several of its arborescent arms to their utmost, apparently an indication that it was ready to feed.

Each of its arms is girdled with tiny hooks that probably assist in holding its prey. When shrimp blundered into
the animal, the sensitive "twi
quickly rolled up on themselves, fo
ing small "knots," at the center
which were the struggling shri
Eventually, the whole arm slo
curled downward and under the b
to reach the mouth, which is on
basket star's underside. Transfer
food to mouth has not been witness

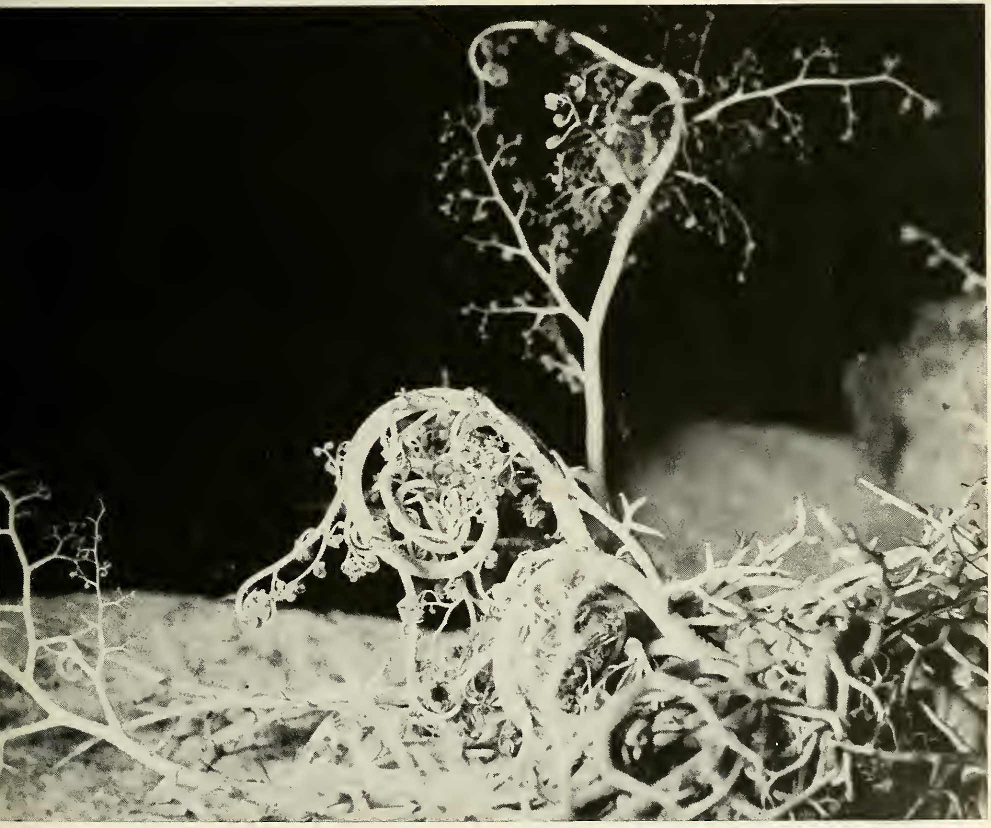
Dr. Atz is the Associate Curator of the New York Zoological Society's Aquarium, located in Coney Island.



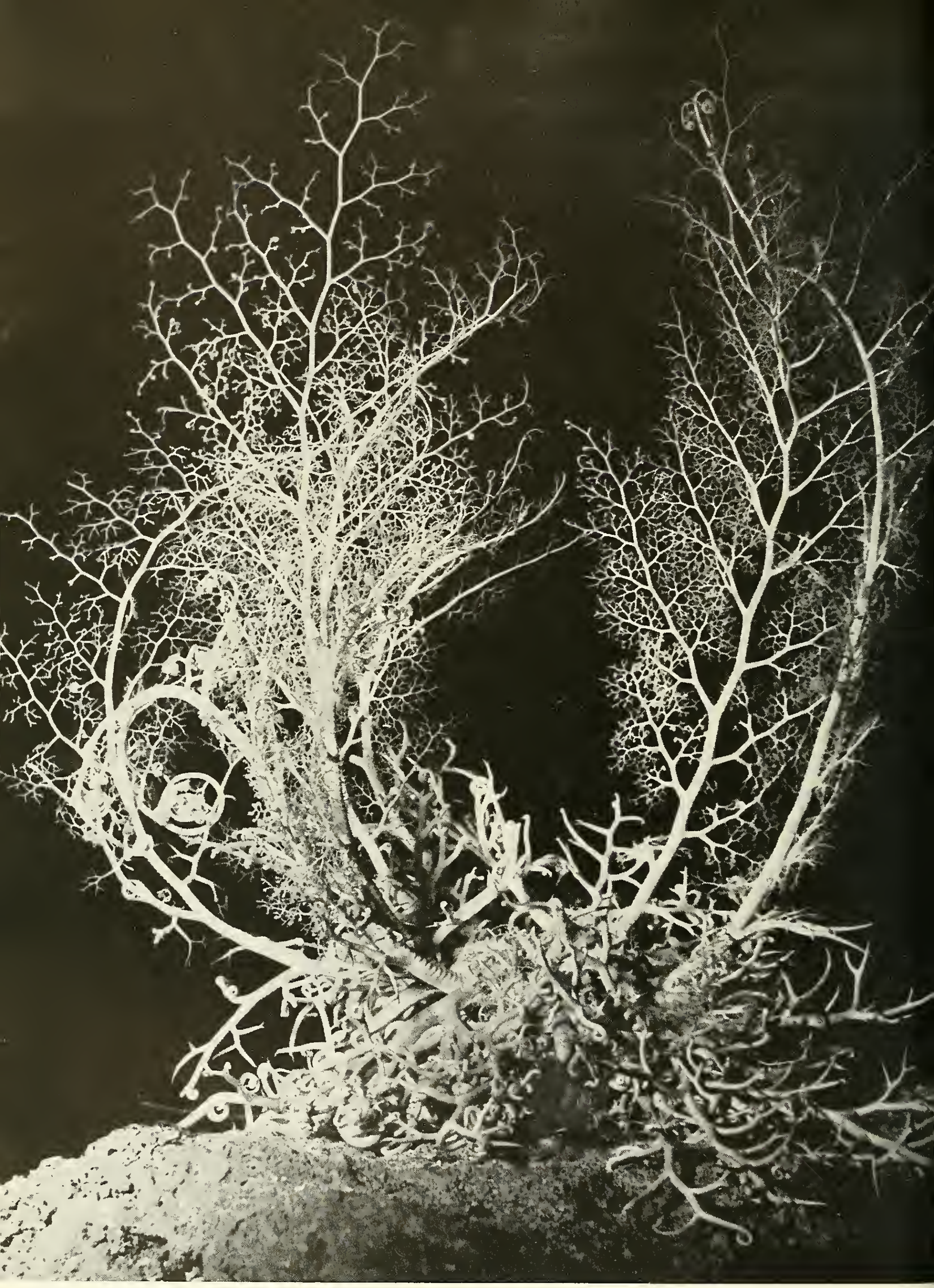
IE SHRIMP are fed to fully extended basket star, *left*.
arm tips knot around prey, *above*, and begin to curl.



SEVERAL TIPS now embrace struggling brine shrimp. At this point, the entire branch begins to roll slowly downward.



N FROND appearance of basket star is plain when coil
ompleted. Now the contracted branch transfers shrimp to animal's mouth, located on underside of its central disc. Exact method of this transferal process is not yet known.



Efficient traps of the basket star are evident here. The several, fully extended, almost motionless branches look like harmless marine vegetation. These are stimulated to acti when bumped by small, floating or swimming organism

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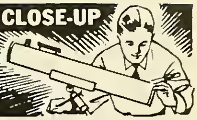

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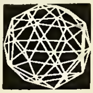

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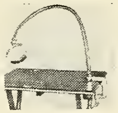

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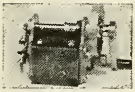

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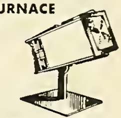

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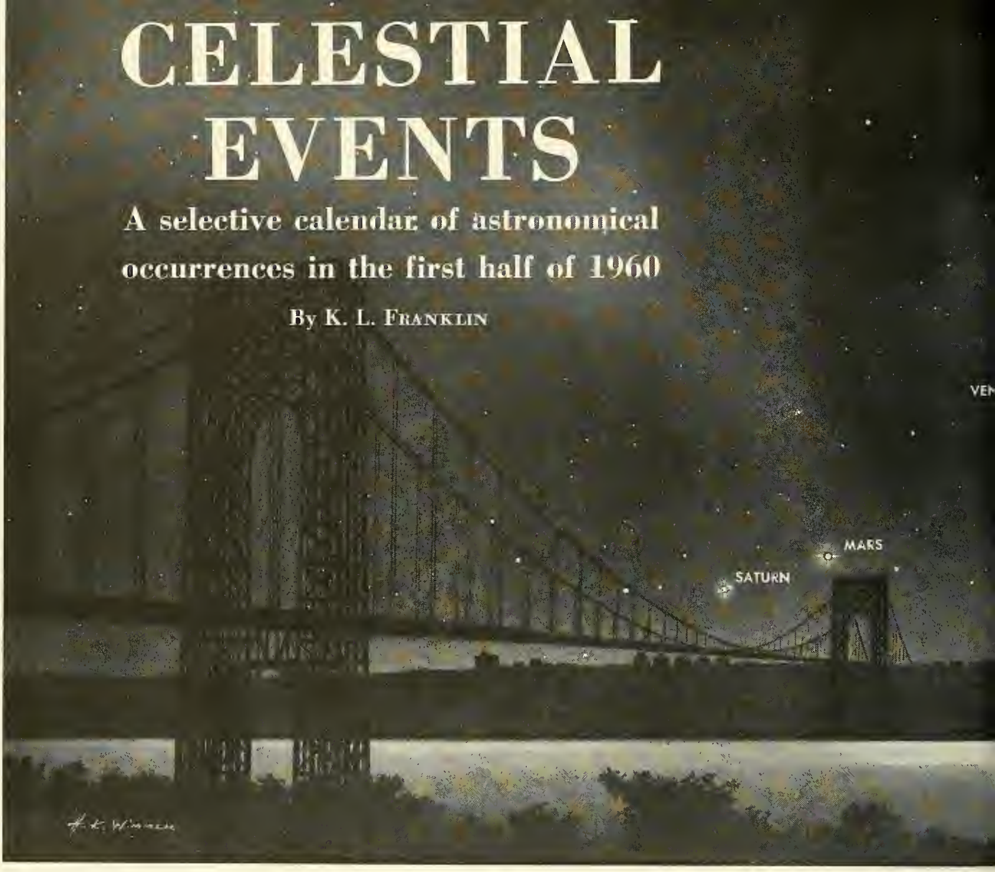
CELESTIAL EVENTS

A selective calendar of astronomical occurrences in the first half of 1960

By K. L. Franklin



JANUARY

January 3: The Quadrantid meteor shower should reach its maximum about midnight, EST. The swift streaks of light will appear to emanate from a point in the northeast sky near the handle of the Big Dipper.

January 4: The earth, in the yearly circuit of its orbit, is closest to the sun—91.4 million miles away.

January 9: The moon will approach Aldebaran during the entire night, finally occulting the star about the time of moonset for the eastern seaboard—around 4:00 A.M., EST, on the morning of January 10.

January 21: Those who rise early in the morning will be able to identify bright Venus low in the southeast, about 1° north of fainter Jupiter.

January 25: Venus, Jupiter, and the waning crescent moon will appear to planet-watchers as they raise their eyes progressively above the southeastern horizon. This is the scene illustrated, *above*, from an imaginary position on the New Jersey bank of the Hudson River. Saturn and Mars are also to be noted, to the left and near the horizon.

January 26: Early this morning, the moon, now even lower in the southeast, will be found between Saturn and Mars (Mars will be higher in the sky).

January 26: Mercury is at *superior conjunction*, 131 million miles away from the earth beyond the sun.

FEBRUARY

February 7: Venus will appear startlingly close Saturn—less than 0°.2 away about 6:00 A.M., EST.

February 17: Venus will appear about 1° north Mars just before dawn today.

February 24: Mercury is 18° east of the sun t evening. One must look carefully just south of west spy this difficult-to-see planet shortly after sunset.

MARCH

March 4: Aldebaran will be occulted by the mo very early in the evening, too early for observers in western U.S. Those living in the northeast may see event with telescopes or binoculars before 5:00 P.M., ES

March 10: Mercury is nearly between the earth and sun today, at *inferior conjunction*, 58 million miles aw

March 12-13: The moon will become full during morning hours of Sunday, while in the midst of earth's shadow. This total eclipse of the moon technica begins about 12:30 A.M., EST, on March 13, but li change will be noticed for thirty or forty minutes. T dense part of the earth's shadow, the umbra, will app on the lunar surface at 1:38 A.M., EST, and totality w begin at 2:41 A.M. The moon begins to leave the shad about 4:15 A.M., the deepest part of the eclipse occurri

3:30 A.M. The spectacular part of the eclipse ends the moon completely leaves the umbra at 5:18, echnical ending coming at 6:22 A.M., EST. This e will be visible over the entire Western Hemisphere.

RCH 20: *Spring* comes to the Northern Hemisphere 43 A.M. EST; *Autumn* begins south of the Equator.

RCH 25: Two days before new moon, the moon ts the planet Mercury, about 7:00 A.M., EST. Tele- s should be used to see this event from the eastern f the U.S., for the sun will have risen an hour before.

RCH 27: A partial eclipse of the sun will be visible much of Australia and Antarctica.

APRIL

RIL 7: Mercury is as far west of the sun (28°) as it e this season. Look at dawn low in the southeast.

RIL 21-23: The Lyrid meteor shower should reach aximum on the night of April 22. Appearing to te from the small constellation Lyra—near the bright Vega—this shower has occasionally been spectacular. g the past few years, the rate has been between nd twenty meteors an hour for the single observer.

RIL 24: At 2:02 A.M. on this date, people in most rn Standard Time regions will advance their clocks our to 3:02 A.M., starting Eastern Daylight Time.

MAY

MAY 1-10: The waxing moon may interfere with observation of the Eta Aquarid meteors, which will reach a maximum rate of about twenty an hour for the single observer on May 5.

MAY 17: Mercury is again at *superior conjunction* (*see* January 26), beyond the the sun, 123 million miles away.

JUNE

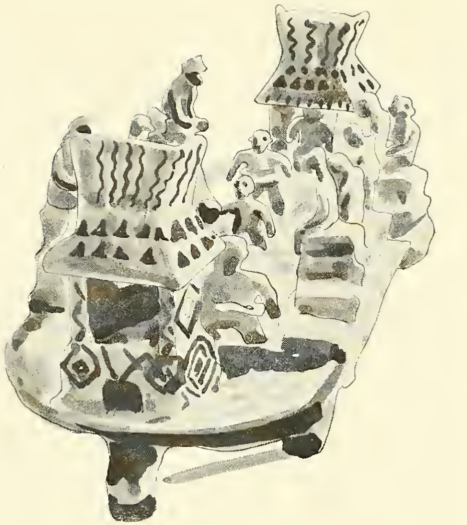
JUNE 9: The full moon occurs 13 hours before *perigee* (when the moon is closest to the earth, 222,000 miles away). This combination will work to produce unusually low and high tides for a few hours.

JUNE 19: Mercury should be fairly easy to see in the western sky shortly after sunset. It is as far east of the sun (25°) as it will be this season.

JUNE 20: Jupiter is opposite the sun in the sky, appearing due south in the midnight sky.

JUNE 21: *Summer* starts at 5:43 A.M., EDT, in the Northern Hemisphere; *Winter* begins south of the Equator.

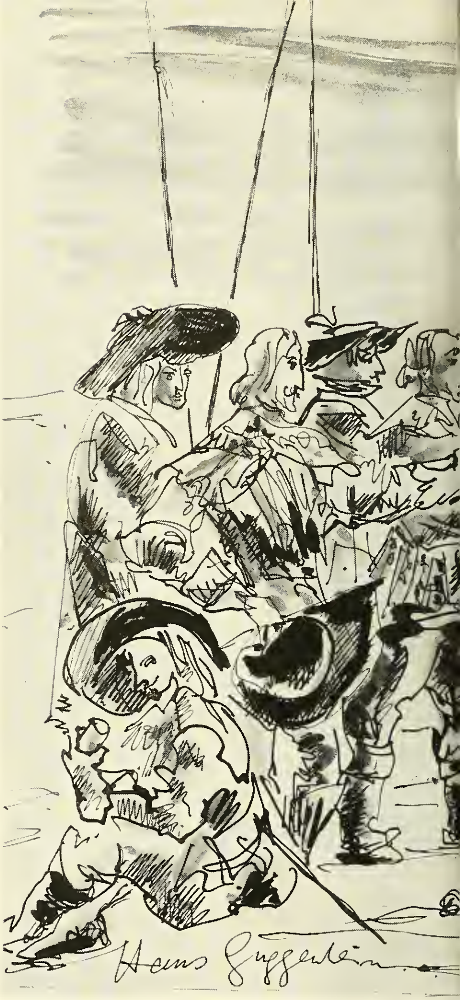
DR. FRANKLIN *of* **THE AMERICAN MUSEUM—HAYDEN PLANETARIUM, prepares this summary each six months.**



AMERICA'S BALLGAME

These dashing New World contests seem to have influenced the form of several team sports of today

By Stephan F. de Borhegyi

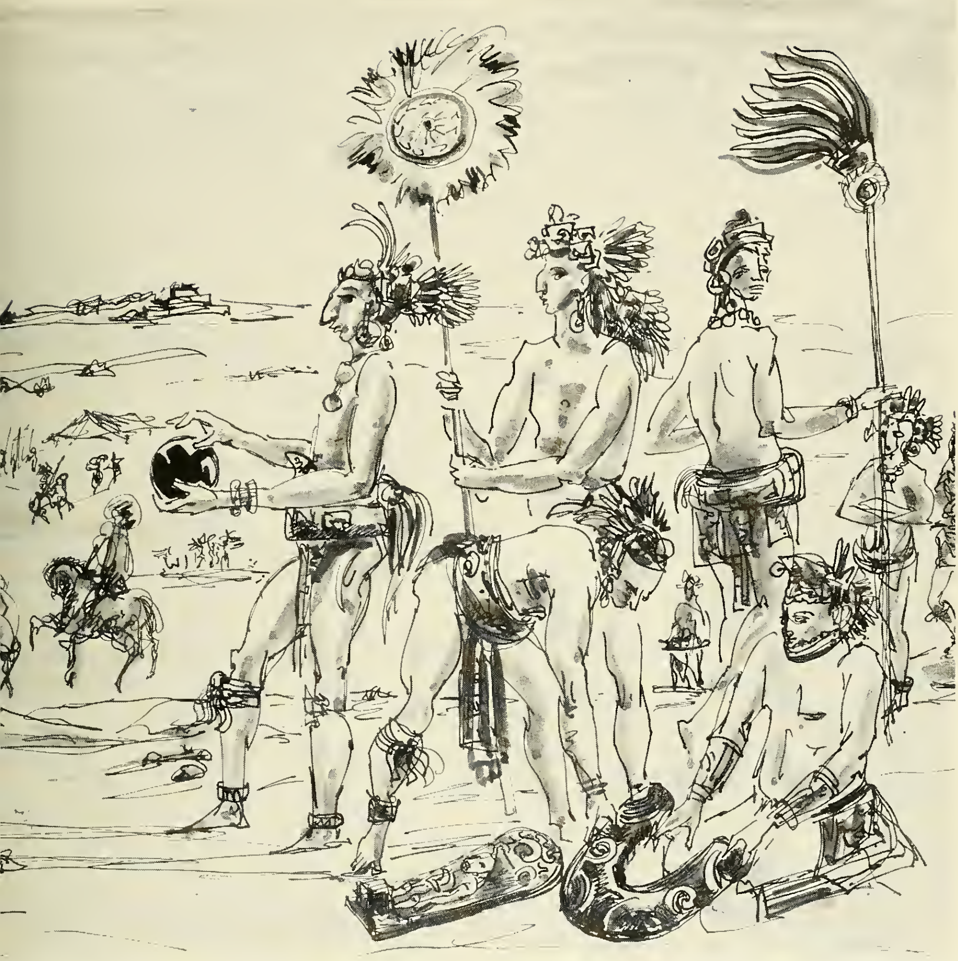


Ball games were so much a part of Mesoamerican cult that clay models were made of the event, *top, left.* F

But for the sporting enthusiasm of our Indian predecessors in the New World, competitive rubber ball games—as we know them today—might never have come into existence. Not only were the enterprising people of Mesoamerica responsible for the discovery of rubber—and its usefulness in the form of an ingenious, bounding, rubber ball—they may also have done much to influence the form in which some of our modern games of ball are played.

When the Spanish conquerors arrived early in the sixteenth century, they first witnessed a New World ball game in the Antilles, on the island of Haiti. Later, they saw ball games played on the Mexican mainland. They especially marveled at the ball *(olin)*, which was solid and heavy and yet bounced so vigorously. The Spanish chronicler Torquemada (in 1613) described this unusual object from hearsay: "These Indian peoples know (as among us was known) the ball game, although differ from ours. The place where it is played is called *tlacl* which is like tennis among us. They make the ball fr the sap of a tree which grows in the hot country, fr which trickle some white thick drops when it is punctur and which very soon jell, which when mixed and knead turns out blacker than pitch. Of this *ulli* they make th balls which although heavy . . . were very fitted for way in which they played. They bounced and jumped lightly as air-filled balls, and were better because th was no necessity for blowing them up."

An earlier account, by the chronicler Duran (158 combines direct observations with detailed reporti "This ball is—as some people may have seen—as la as a small ball used in playing nine-pins. The mate of which the ball is made is called *olin,* which I h heard to be called '*batel*' in our Spanish, which i



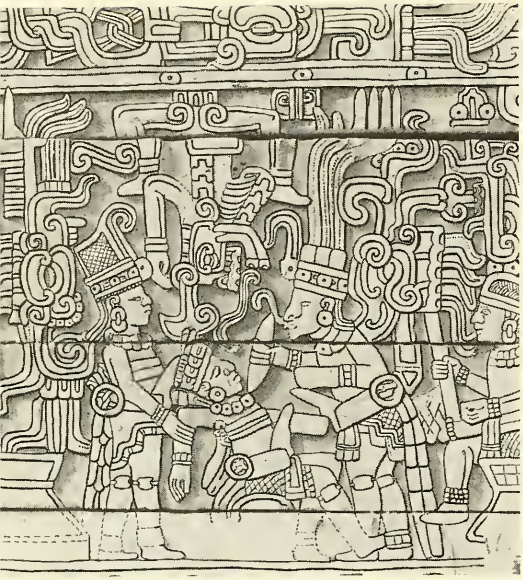
:an witnesses of such play were Spanish explorers, to Indians presented game's trappings, *above.* Earlier,

Columbus had brought back a marvelous ball that "jumps and rebounds"—probably the first rubber ball to reach Europe.

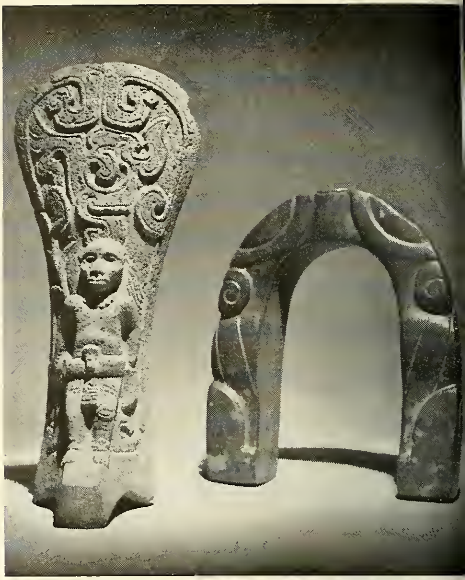
›f a special tree which when boiled becomes like . It is plentiful and used . . . both as medicines and ring. It has one property which is that it jumps bounds upwards, and continues jumping from here e so that those who run after it become tired before atch it."

no surprise, then, that Columbus brought back an mple of such a ball, along with other wonders from w World. Las Casas, writing from New Spain in ·emarked, "I saw one, as big as a small jug, which l Admiral brought to Seville." It can therefore be ·d that, not long after Columbus' second voyage, —and the rubber ball—were brought back in some ties to Spain and to the rest of Europe, along with s accounts of the New World ball games. The itself seems to have been introduced to Europe in the year 1528 by Cortes, who staged several games for the court of Charles V. One of these performances was witnessed by the German traveler Christoph Weiditz, on a trip to Spain in 1529. Shortly afterward, he published a description of his trip, the excellent illustrations of which included a sketch of two Indian ball game players and, in the text, some brief rules.

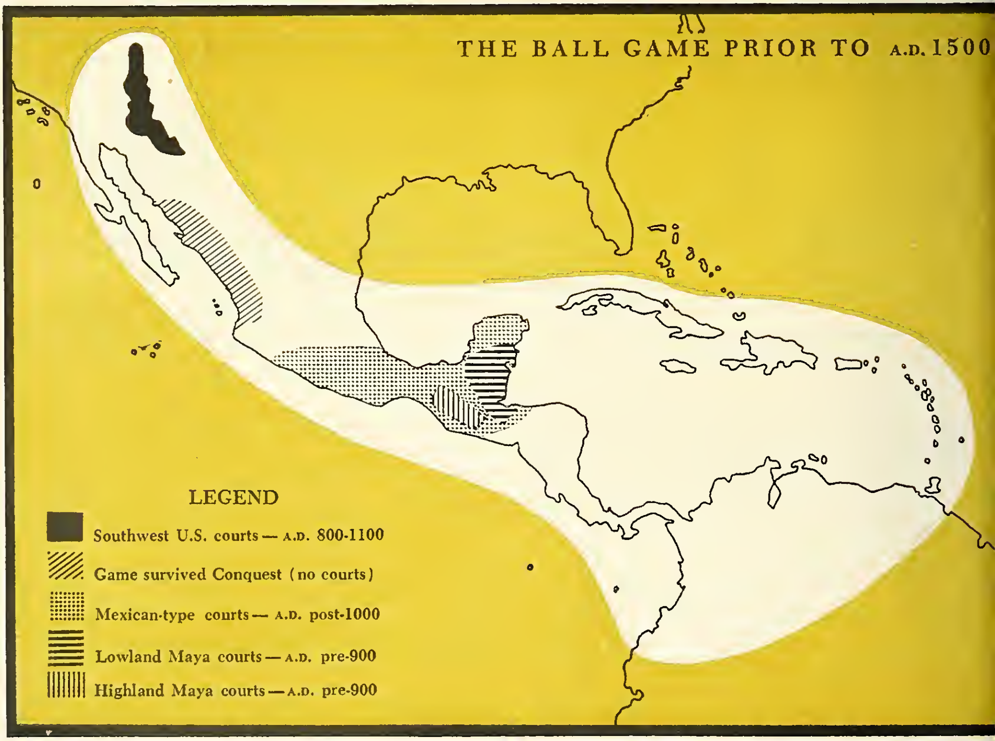
In Torquemada's description of New World ball games, which he calls "*juego de pelota,*" he mentions their similarity with the essentially sportive European ball games—in particular, court tennis and the *pelota vasca*, or *jai-alai*. However, prior to the Spanish Conquest, all the ball games that were played in Europe made use of leather balls that were either filled with hair or contained an inflated bladder. Indeed, the Spanish word for ball is still *pelota*—deriving from the word *pelo*, meaning "hair." The most popular ball games in Spain, France, and Italy



Ball player being sacrificed with obsidian knife, *above*, can be seen in frieze on ball court at El Tajin, Veracruz.

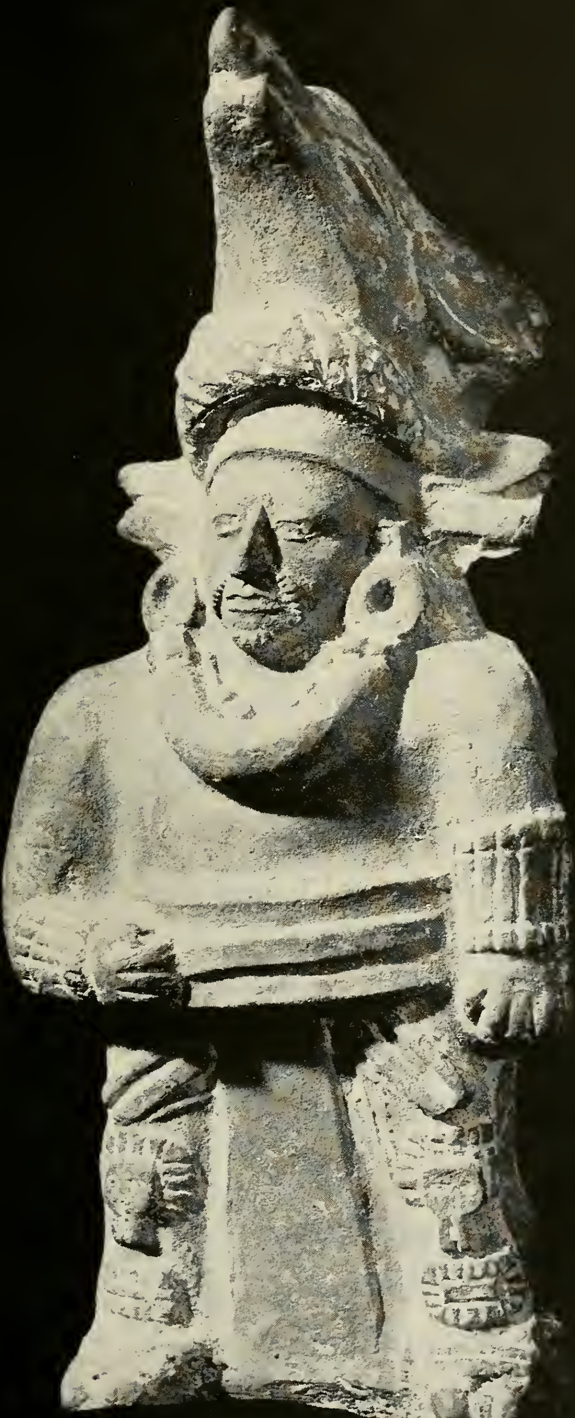


"**Palmate stone" and yoke**, *above*, may have been wor play, but were more probably used only in game ceremon

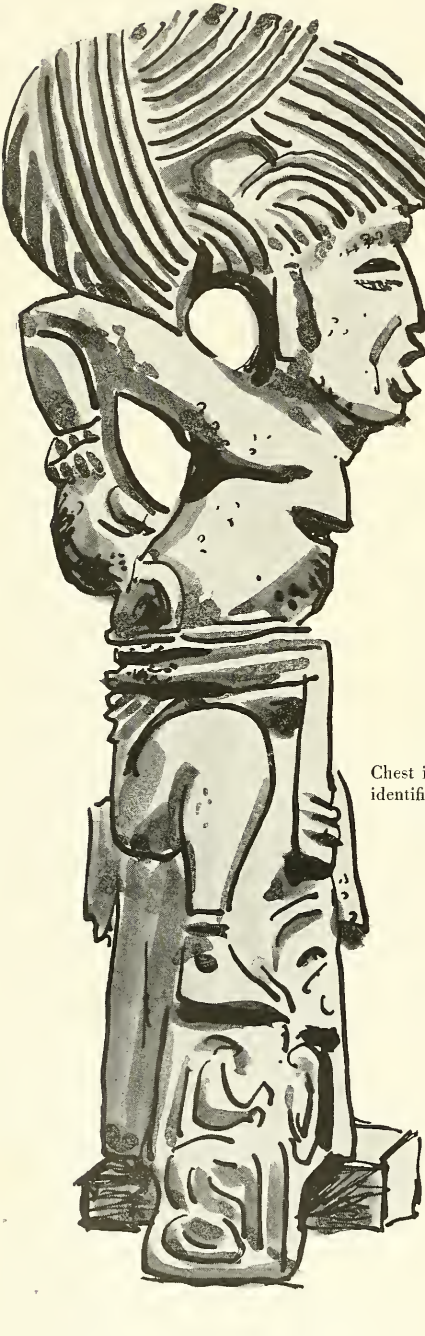

THE BALL GAME PRIOR TO A.D. 1500
LEGEND
■ Southwest U.S. courts — A.D. 800-1100
▨ Game survived Conquest (no courts)
▒ Mexican-type courts — A.D. post-1000
☰ Lowland Maya courts — A.D. pre-900
▥ Highland Maya courts — A.D. pre-900

Middle American ball games were played on varieties of courts indicated on map, *above*, during pre-Conquest period.

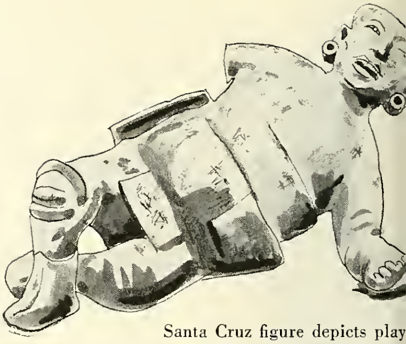
Pottery whistle, *right*, is effigy of ball player. Note pads on arms and legs, and headdress in form of ani



Illustrations by **Hans Guggenheim**

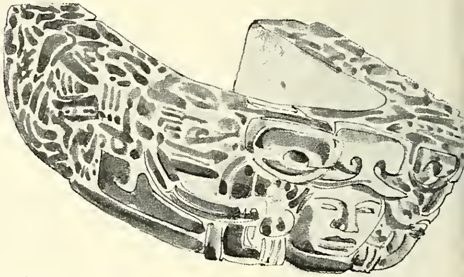


Chest incision in carving
identifies a sacrificed player.



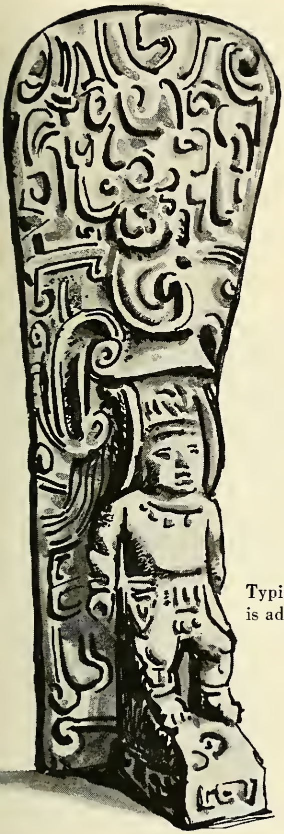
Santa Cruz figure depicts play
wearing stone or wood yoke.

Elaborately carved stone yoke
is from Veracruz area.

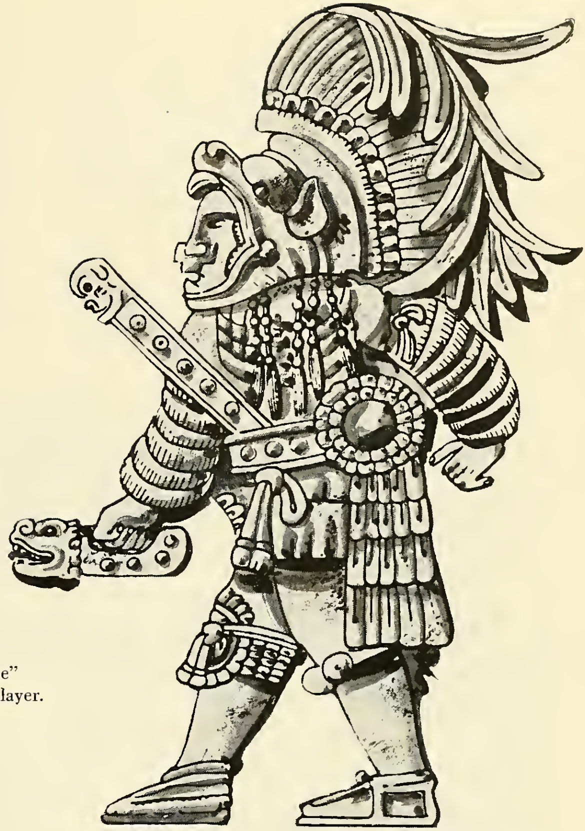


during the fifteenth century were *pallone* or *bal*
(words that have the same root as the English wo
"balloon," since the game was played with an air-fill
ball) and court tennis, which was a hand game *(jeu*
paume), played with a hair ball.

Both these games derived from Roman prototyp
and had even earlier Mediterranean origins. Thes
and all other European ball games prior to the sixteen
century, seem to have originated in ancient, spring rit
practiced in southern Europe, Egypt, and the Near Ea
The two-sided aspect of the game probably represent
the philosophic dualism of nature. In this ritualist
pairing, we may have the origin of "teams"—mock co
bats and contests dramatizing the eternal conflict betwe
day and night, or dying winter and approaching su
mer. However, the emphasis was apparently on each in
vidual's skill: there seems to have been no serious attem
to organize the opposing players into co-operative team
Thus, the New World idea of two teams engaged in co
petitive play was quite possibly an innovation to Europ



Typical "palmate stone" is adorned with ball player.



Player in full regalia appears on Chichen ball court frieze.

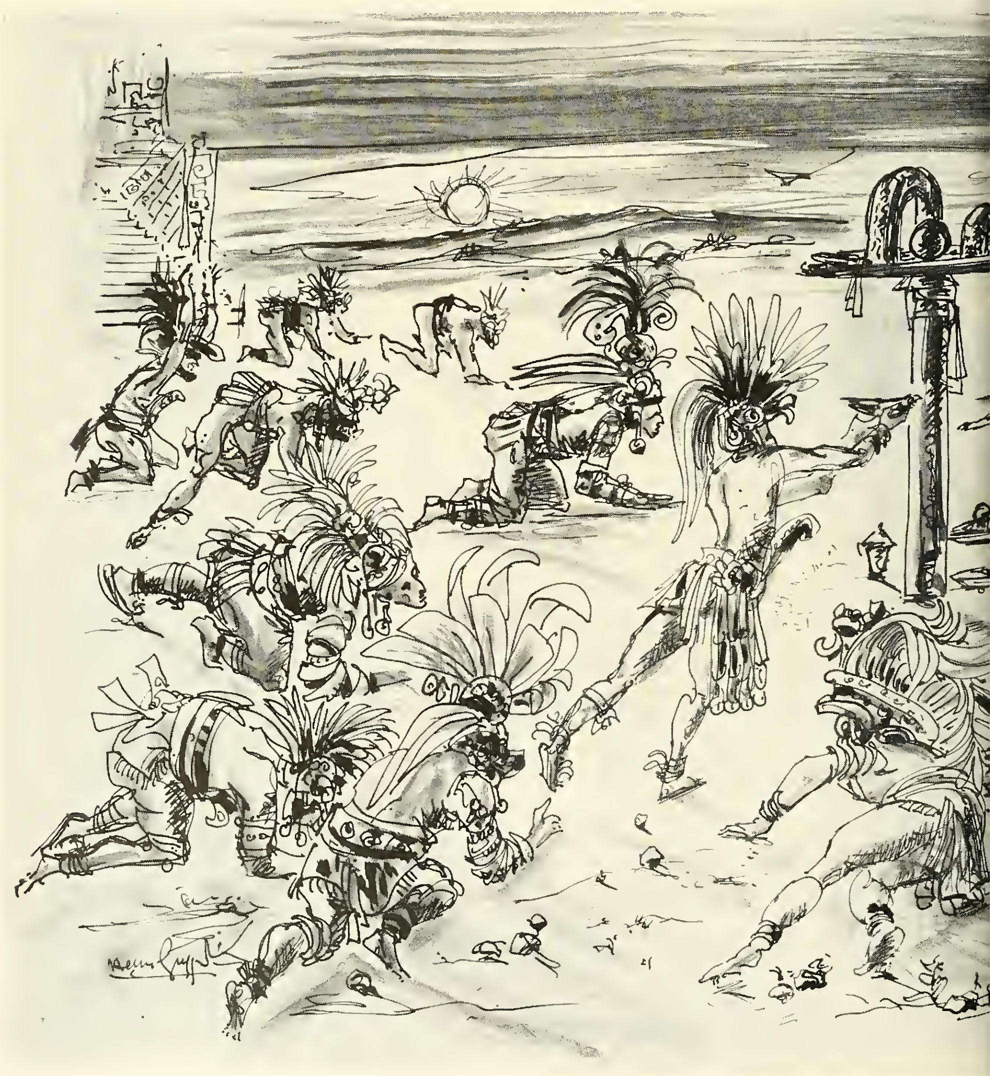
e Middle American ball game, as described to us by
ɔanish chroniclers, was a combination of our modern
s of basketball, volley ball, soccer, and *jai-alai.* It
ɔlayed in high-walled, paved courts (usually 100 to
eet long and 20 to 50 feet wide), called *tlachtli* or
:o, the floor plans of which were in the shape of a
tal I." As described by the Spaniards, the game had
key the knocking of a solid, five-pound rubber ball,
o eight inches in diameter, through stone "hoops"
ertically in the center of each of the two long walls.
main objective of the play does not seem to have
to gain ground—as was the case with most of the
enth-century European ball games — but to score.
the inner diameter of the stone hoop varied from
ɔ twelve inches, making a "goal" was no easy task.
ever, the game varied from place to place, and in
areas, hoops were not used at all. In these cases,
ng must have been calculated on some other basis.
e number of players varied. There were amateur and
ssional teams and nearly every pre-Columbian set-
nt of any size boasted at least one ball court. In some contests, quite large teams—nine to eleven players strong—were used. In others, only two or three expert players took part. To quote Torquemada again: "They played in teams, so many against so many, such as two against two, and three against three, and sometimes two against three, and in the main courts or *tlachco*'s the lords and nobles and great players, in order to embellish their markets principally on feast days and on many other days, went to play in them."

How the ball was first put into play remains unknown. But, once begun, the players performed with such skill and dexterity that there were times when the heavy rubber ball did not touch the ground for as long as an hour, during which it flew from one end of the ball court to the other. A team "scored" whenever the opposing ball-handlers missed a shot at the vertical hoop, or when the team made the ball reach the opponents' "end zone." Playing the ball off the side walls was quite important, and many of the finer tricks of the game were apparently based on the players' skill in this maneuver.

The most important score, however, was accomplished by putting the ball through one of the stone hoops. When this occurred, all other scoring points were discounted and the game was thereby concluded in great excitement and applause. Torquemada testifies: "This way of putting the ball through the hole, which we have seen, which seemed a miracle to the spectators (although it was by chance), they used to say and swear that the person must be a thief or an adulterer or that he would soon die, since he had had so much luck; and the recollections of this victory lasted for many days until another happened which made it forgotten."

The star player who accomplished this remarkable feat not only won the game for his team but was entitled, for his skill, to collect the jewels and even the clothing of those who were watching. Generally, a merry scrar ensued and there was a mass exodus of all present.

Star players were highly honored by chiefs and c moners alike, but the game was so strenuous that i hard to imagine that the stars could have remained at top of their form for long. The heavy ball was not lowed to come into contact with bare hands, feet, calves, but was kept in play with a sort of hand-held st "flatiron" or with elbows, knees, and hips. Protection the players consisted of quilted cotton elbow and k pads, and around their waists they wore heavy belts, yokes, of leather or basketry. Sculptures and painti often show ball players equipped with these stone "glov and wearing yokes, as well as curious objects known "palmate stones" (*illustration*, p. 50). Both yokes car



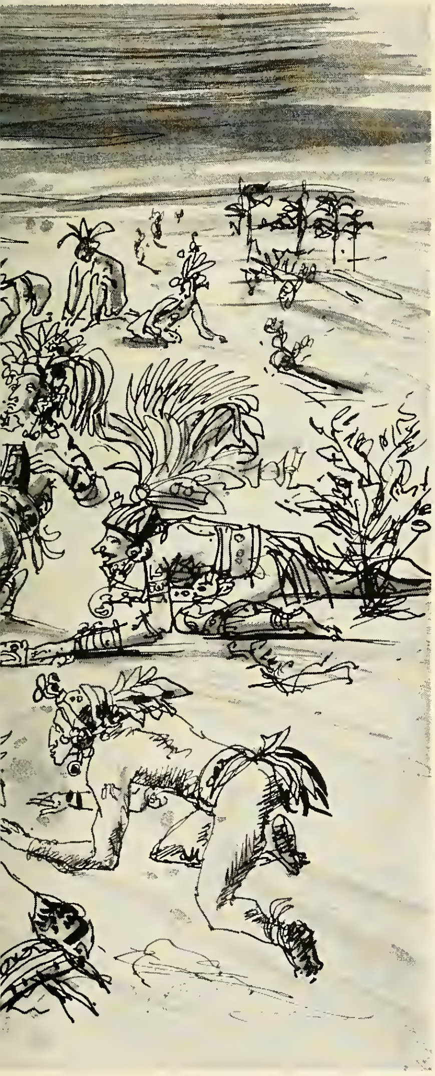
stone and the palmate stones, themselves, have been ered by archeologists. It is not known, however, er this bulky equipment was actually worn in play, ether the stone versions were made solely for cere-l purposes. Evidence tends to show that the stone -some weighing as much as fifty pounds—might been used in some areas, to give the ball a better e. The palmate stones, on the other hand, are quite , and it is unlikely that they could have survived gors of actual play.

all their protective costume, casualties happened during the course of the game. Says the eyewitness : "Some of them were carried dead out of the nd the reason was that as they ran, tired, and out ath, after the ball from one end to the other, they would see the ball come in the air and in order to reach it first before others would rebound on the pit of their stomach or in the hollow, so that they fell to the ground out of breath, and some of them died instantly, because of their ambition to reach the ball before anybody else. . . . They were so quick to hit their knees or seats that they returned the ball with an extraordinary velocity. With these thrusts they suffered great damage on the knees or on the thighs, with the results that those who for smartness often used them, got their haunches so mangled that they had those places cut with a small knife and extracted blood which the blows of the ball had gathered."

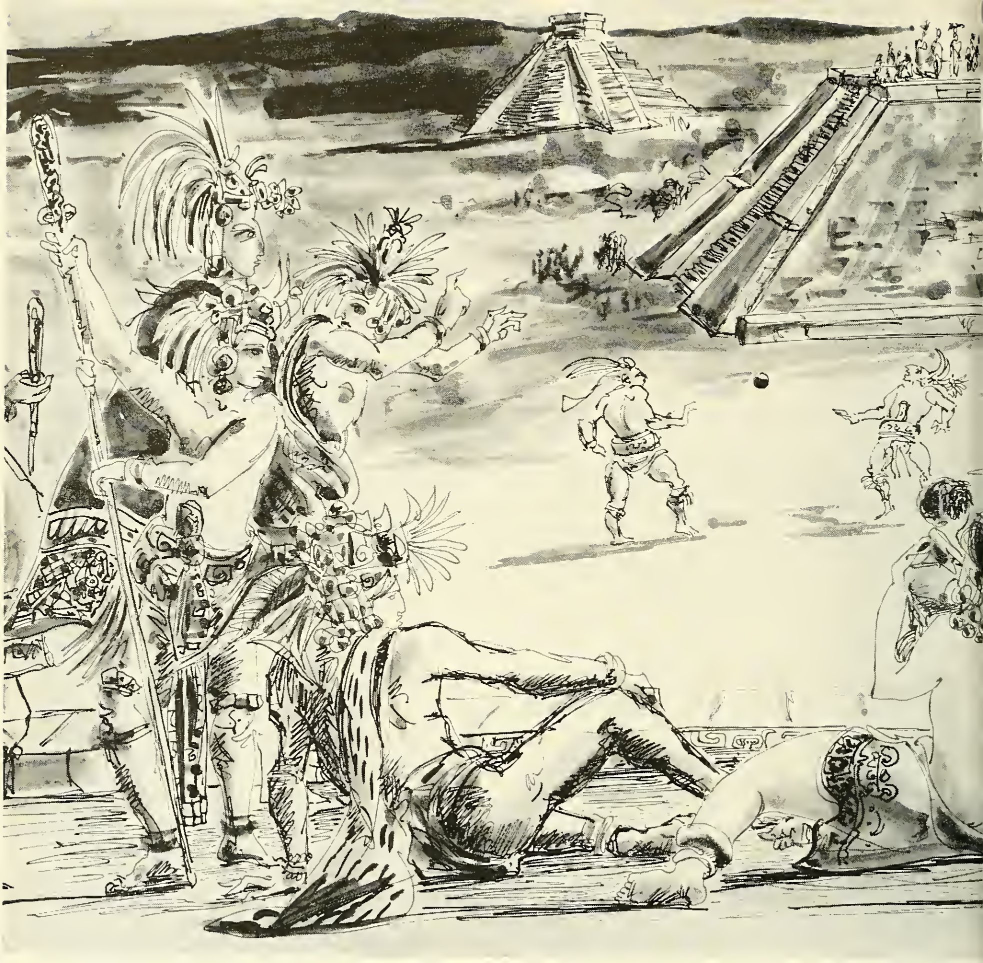
In spite of the fact that players often were severely hurt and occasionally were killed, the rewards of being a star were so great that such dangers were evidently considered inconsequential. Yet, there was even greater risk involved for the team captains. While the winning captain was overwhelmed with honors and gifts, the unfortunate captain of the losing team was not infrequently sacrificed to the gods! This fact we know from the Spanish chronicles. It may also be reflected in the dramatic depictions in low relief on the ball courts, at El Tajin, in Veracruz, and at Chichen Itza, in Yucatan, and in the illustrations contained in such documents as the *Codex Borgia.*

ALTHOUGH such treatment of the losing captain may seem harsh, it was closely in keeping with the penalties imposed by the spectators upon themselves when they lost at the gambling that invariably accompanied the game. Both players and spectators laid wagers on the outcome of the contest, the stake varying with the status and wealth of the individual. As the chronicler Sahagun (1529) reports: "What the low class people gambled was jewelry of small value and worth and as he who has little wealth on hand usually loses it, they were in necessity of gambling their houses, fields, maize stores, maguey plants and of selling their children in order to gamble and even of gambling themselves away and of becoming slaves, to be sacrified if they did not redeem themselves in time, as has already been told. Their way of gambling was that when they had finished losing the valuables which they carried, such as cloaks, beads and feathers, they would gamble on their word, saying that they had certain valuables in their houses."

Rulers might even play for principalities or kingdoms, as when Axayacatl, the ruler of Tenochtitlán (today, Mexico City), wagered his entire yearly income against that of Xihuitlemoc, the ruler of the neighboring city of Xochimilco. Lesser nobles and chiefs played for jades and turquoises, jewelry of gold, feather robes, articles of clothing, cocoa, cornfields, houses, and for slaves and concubines. With so much at issue, it is little wonder that there were times when, not content with the element of skill, such high-stake participants invoked the aid of the supernatural. According to Duran: ". . . these gamblers by nightfall took the ball and placed it on a clean plate with the leather loincloth and the gloves, hanging it all on a pole and, crouching before these instruments of the game,



HEAVY BETTING preceded ball games, with jewelry, slaves, and even kingdoms changing hands. Gamblers would invoke aid of spirits, *left;* placing trappings of the game on pole and praying to the gods of luck to favor them the next day.



Spectators watched game from top of court walls. *above.* Courts were usually 100 to 125 feet long and from 20 to 50

feet wide. but game methods varied. In some courts, sc
were made by knocking balls through stone hoops on w

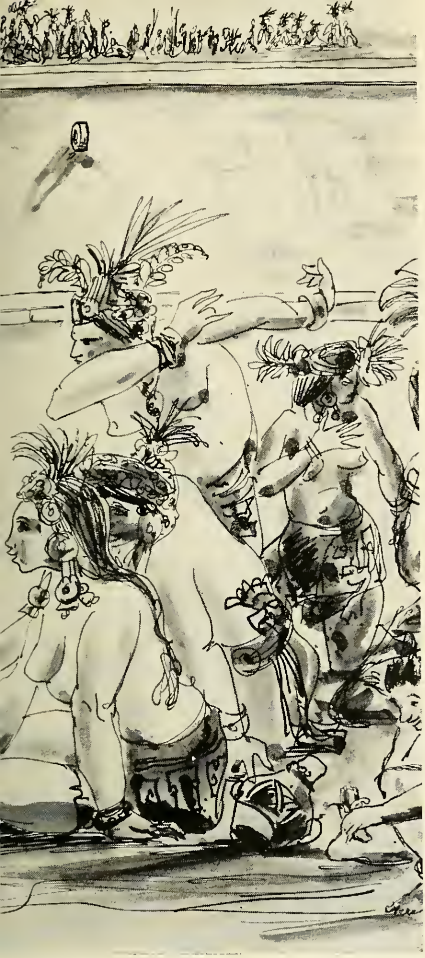
they worshipped them and spoke to them with certain words of superstition and incantations with much devotion, praying to the ball that it. . . be favorable that day."

All this might give the impression that, by the time of the Spanish Conquest, the Middle American ball game was a completely secular activity. Duran even describes it as ". . . a game of much recreation to them and enjoyment especially for those who took it as a pastime and entertainment." Nevertheless. the religious overtones that reflect the sacred origins of the game were apparent to Torquemada. who recalled: "Each ball court was a temple because they placed two images in it. the one was the god of the game and the other of the ball. on the top of the two lower walls, at midnight. on a day of good omen, with certain ceremony and witchcraft and in the middle of the floor they made similar ceremonies, while singing songs: thereafter one of the priests with some of his ministers came to bless it with certain words (if the

detestable superstition can be called blessing); he th
the ball four times in the ball court and with this t
said that the court was consecrated. and they could p
in it and not before then."

In the codices. we continually see the gods associa
with the ball court. Those most frequently illustrated
Quetzalcoatl. Texcatlipoca. Xochiquetzal, Xochipilli. H
zilopochtli, Coatlicue, Xolotl, and the Lords of the
and the Night. These divinities were even believed to
ardent players in their heavenly courts, like the vigor
athletic gods of the Greeks, and the ball game wa
favorite means of settling their divine disputes.

From the various legends. we learn that Quetzalc
was an unusually skilled player and had many ball co
dedicated to him. Historically, Quetzalcoatl seems to h
been the culture hero of the Toltecs and ruler of the
of Tula. His defeat by his rival and arch-foe. Texca
poca, and his subsequent flight to the south has b
passed on to us through a legend, recorded by Sahag



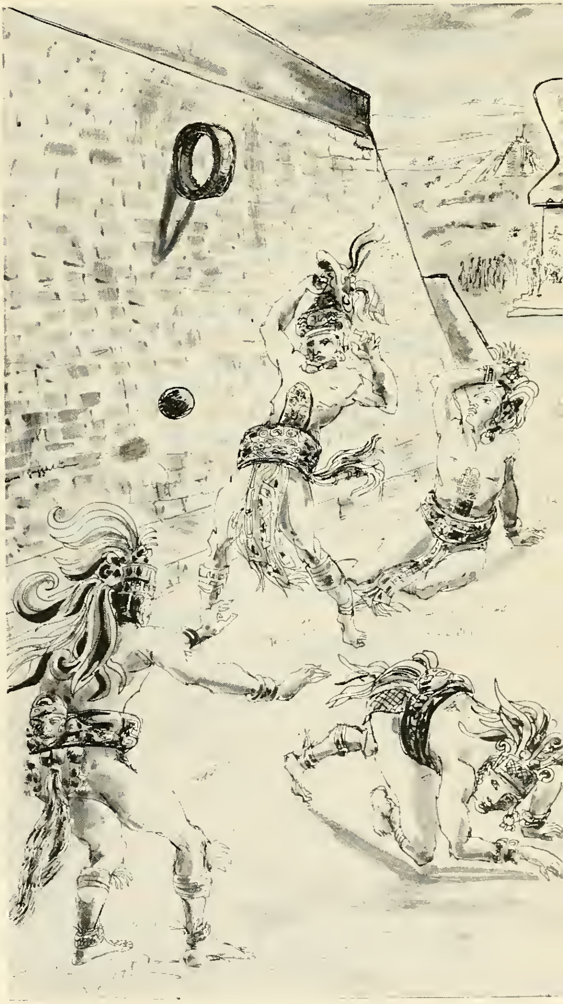
n by two teams, *right.* Five-pound ball was kept in thout use of hands, and players often were injured.

has this momentous conflict taking part on the
all court of Tula.

eover, the twin brother of Quetzalcoatl, Xolotl, was
throughout pre-Columbian Mexico as the divine
of the game. In this, one may detect an inherent
ship between this god of twins or siblings and the
implicit in competition: a factor that, as we have
was also present in the origins of Old World ball
One can suspect that, as in Europe, the underlying
tion of the Mesoamerican ball games was to pro-
outlet for aggressions toward neighboring groups
means, short of warfare, for settling disputes.

liddle America, the game was so immensely popu-
t almost every ceremonial center had at least one
urt and some of the larger ones held as many as
fifteen. Various versions of the ball game were
in pre-Columbian times from as far south as El
or to as far north as central Arizona, and throughout
nds of the Antilles.

JUST where the game originated is yet to be determined. The invention of the rubber ball and its use in a ball game very likely took place through experimentation in an area where rubber-bearing plants were grown. This would suggest the lowland rain forests of Central America as a point of origin. Verifying this hypothesis, we find the earliest ball court known thus far at the important jungle site of Copan, in Honduras. This court has been dated at between A.D. 200 to 300, in the Early Classic period. Since there is nothing primitive about this Copan ball court, we can probably assume that others—representing the experimental beginnings of the game and so far not yet found—may pre-date it by several hundred years. As a matter of fact, archaic figurines, representing ball players, were found at Tlatilco, Mexico—which suggest that some form of the game was known in the Valley of Mexico as early as 1500 B.C., although it may not have been played in a formal ball court.



DR. BORHEGYI is an anthropologist and the Director of the Milwaukee Museum. A specialist in hispanic cultures, he has concentrated on studies of Mesoamerican archeology.

THE type of classic ball court at Copan consists of an open-ended court, with a central playing alley between parallel, sloping side walls. Three elaborately carved, square or circular stone slabs apparently represented floor markers. At the top of each side wall were three vertically tenoned, stone parrot heads. Since these parrots were carved with large, round eyes, it is possible that they represent a precursor of the stone hoops found in later, Mexican courts. The floor markers were also important in scoring. This type of court was characteristic of the lowland Maya region of Guatemala, Honduras, and Mexico and survived to the end of the Classic period, possibly as late as A.D. 1000.

In the highlands of Guatemala and southern Mexico we find another type of ball court during the Classic period (A.D. 300 to 1000) that resembles a wash basin in its shape. This court is, in general, like that of the lowland Maya, but differs in being completely enclosed by a wall, which also incorporates some extra space, at both ends of the playing floor, to form end units. Although we find no evidence of stone floor markers, we cannot eliminate the possibility that goals of some sort may have been painted on the paved floor. The carved stone heads used to decorate these highland courts were characterized by horizontal—rather than vertical—tenons, frequently in the form of serpent and human heads, rather than parrots.

BY the close of the Classic period, most of the lowland Maya centers were mysteriously abandoned. In the highlands of Guatemala and southern Mexico, after A.D. 1000, a new type of ball court came into fashion. Prior to this time, all ball courts were built on the ground level. But in these later courts the playing alley was lowered to a depth of several feet below the surface. It is very possible that this type of "sunken" court was introduced from Mexico, where the game, as we have seen, may have been known since 1500 B.C. Since these post-Classic courts were built below ground level, they all had elaborate drainage systems. Although they retain the sloping side walls and the enclosed "capital I" shape, they show no signs of tenoned stone heads or floor markers. Goals, of course, may have been painted or made of perishable material.

While such "sunken" ball courts were characteristic of the post-Classic period (A.D. 1000 until the Spanish Conquest in 1524) throughout Guatemala and southern Mexico, still another type came into vogue in central and western Mexico and in Yucatan. It is this type that is described in detail by the Spanish chroniclers. Although the playing alley was in the "capital I" shape, it was built at ground level and the side walls were vertical rather than sloping. In the center of each side wall was an elaborately carved, horizontally tenoned, stone hoop.

Little is known of the ball courts in the region north of Mexico City. However, in Arizona, two types of courts have been recognized, both of the "sunken" variety. The one excavated at the Snaketown site is large and oblong and possesses end units. Apparently it was in use between A.D. 800 and 900. Smaller, circular courts—built during a later period (A.D. 900 to 1150)—are characteristic of the Flagstaff area. In these, the end units were replaced by
small openings in the surrounding wall. There is ha
any doubt that the prehistoric inhabitants of Ari
learned of the ball game from their Mexican neighb

Since the shape of the courts varied in different pe
and in different regions, it is easy to conjecture tha
rules of the game must also have varied. Unfortuna
the only eyewitness accounts of the pre-Columbian
game are those preserved in the Spanish chronicle
variation, however, is still played today along the n
western coast of Mexico—in the states of Sinaloa
Nayarit. No formal courts are used and the game
little of its former splendor. Nevertheless, the genetic
tionship is clear: there is a corridor-like playing f
the ball is made of solid rubber and there is the ob
tion to strike it with the hip or thigh. Religious feast
are favored for play, accompanied by lavish betting.

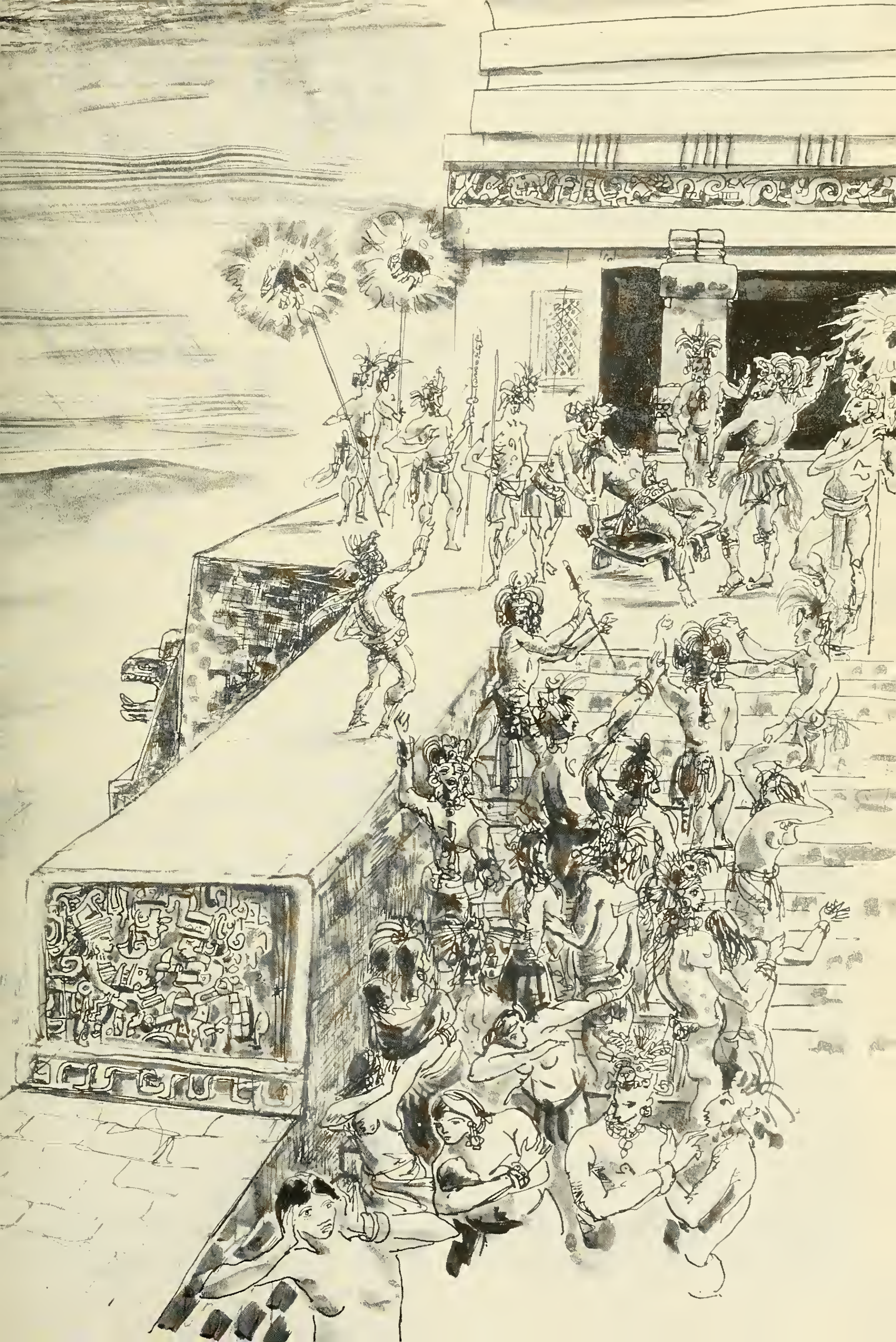
The reason that only this one poor example of a
great game has survived to the present day is appa
in the chronicles. The historian Gomara states—an
corroborated by Cervantes-Salazar and Torquema
that: "Each court was like a temple, because they put
images of the god of the ball game on the lower wa
Motolinia adds, "... and for this reason they were
stroyed." Later historians piously argue that the
game was destroyed by the conquerors out of a desir
protect the Indians from the very real dangers of p
however, such an assumption of altruistic motivatio
at the very least, open to suspicion.

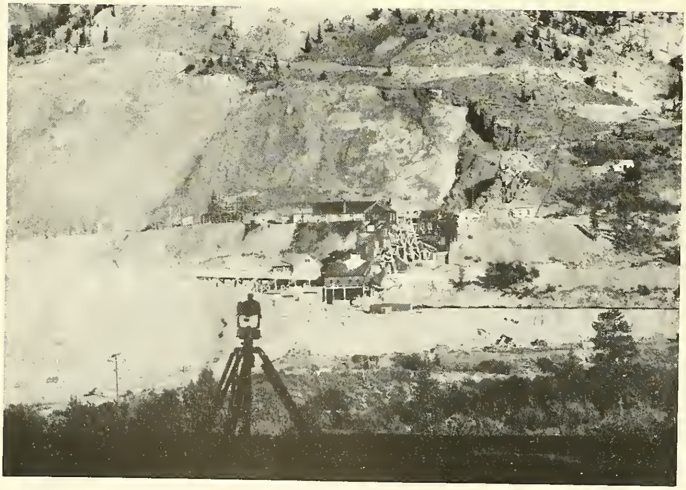
In spite of its virtual extinction, the competitive
game of Middle America lives on through its influe
on the modern ball games of Europe and America.
though there is no indication that the rules of the
World game were ever incorporated directly into
European sport, it is obvious that the element of a vi
ously bouncing rubber ball considerably altered the r
of the ancient game of tennis, and had its effect on
formulation of rules for such kicking games as soccer
football. Team effort to keep the ball constantly fly
from side to side survives in modern volley ball.

THERE is also some reason to suspect a connection
the distinctly American game of basketball—wh
owes its beginnings, in 1891, to Dr. James E. Naism
a physical education instructor at the Young Men's Ch
tian Association Training School at Springfield, Ma
chusetts. In the late 1800's, a great stir was caused in
country with the rediscovery of the ruins of the anc
Maya ceremonial center, Chichen Itza. In 1891, the E
lish archeologist Maudsley published the first article
the ball court there, calling it a tennis court or gym
sium. Dr. Naismith, understandably interested in any
type of sport, may well have read about the ancient
games of Mexico and incorporated the idea of putting
ball through a hoop—albeit horizontal rather than vert
—in his ingenious new game of basketball.

Today, three types of ball games—football, soccer,
basketball—are played throughout most of the West
world. Now thoroughly secularized, they often are acc
panied by the same excitement—and gambling—that o
characterized the Middle American ball game.

TOP OF TEMPLE STAIRS is scene of a player's sacrifice
priest's hands. Such expiation was not unusual result
losing, while the winning captain was heaped with hon





TREMENDOUS MAGNIFICATIO

Here we look across a canyon at a st ture about a third of a mile away. V Questar's flawless slow motions we finc tiny detail we wish to examine—such as hairline cracks in these old timbers—n of which is, of course, lost in photogra and in printing this page. People ac tomed to the 8x of binoculars are as ished to find that Questar magnifies 10 20 times as much, with great clarity no false color.

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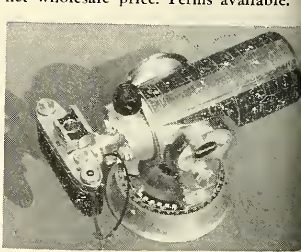

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BOX 60 · NEW HOPE · PENNSYLVANIA

SKY REPORTER

ninth planet, Pluto, was at last discovered only thirty years ago

By Simone Daro Gossner

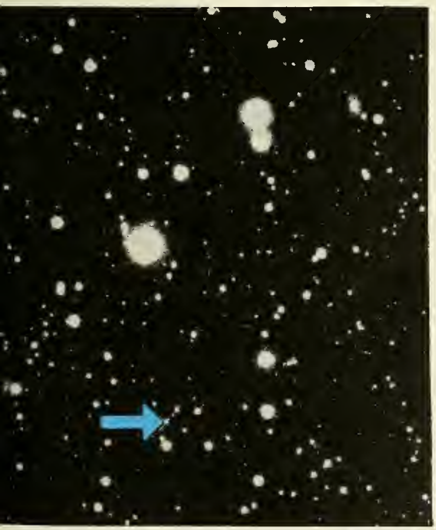
LL STARTED with the discovery of Uranus by Sir
lliam Herschel in 1781. Until then, every known
was visible to the naked eye and it is reasonable
me that the appearance of these five was familiar
o Paleolithic man. The newcomer, on the other
posed a new problem in planetary astronomy: it
cessary to compute an orbit for Uranus in order
is sixth planet might be located for subsequent
ations by astronomers.

he years that ensued, every effort to predict the
f Uranus with accuracy met with failure. Observa-
evealed that the planet was deviating constantly
stematically from its computed orbit. In 1846,
nch mathematician Leverrier showed by means of
ite equations that the erratic behavior of Uranus
doubtedly caused by the attraction of still another
as yet—unknown planet. He even predicted this
i body's position in the sky and persuaded the
n astronomer Galle to look for it. On the first
of his search, Galle found the planet within a
of its predicted location. Thus ends the story of
covery of Neptune, but not of the peculiar behavior
orbit of Uranus.

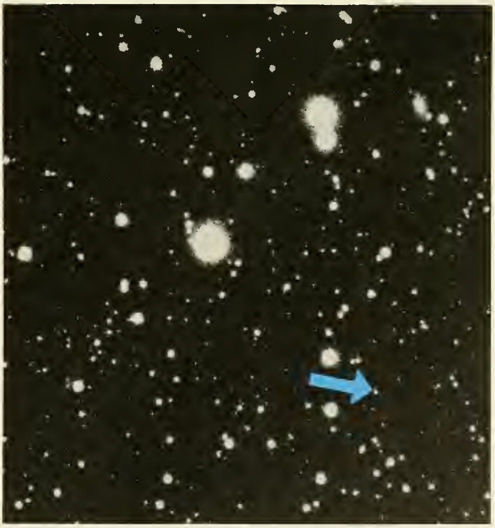
i after the latter was revised to account for the
scovery, it was found that the effect of Neptune
t sufficient to remove the observed discrepancies.
n appeared that the search would have to be
d for another, even more distant, planet. Here
road, a few astronomers undertook to duplicate
athematical feat of Leverrier. Percival Lowell, founder of the Lowell Observatory at Flagstaff, Arizona, and William Pickering, of the Harvard College Observatory, were without a doubt the most persistent and dedicated in this task.

The mathematical procedure followed by Lowell was patterned after the method of Leverrier and made use, once again, of the irregularities in the motion of Uranus. Pickering, on the other hand, devised a semigraphical method—using the irregularities in the motion of Neptune, which had also begun to depart slightly from its computed course. Both men predicted the position of the unknown planet but, alas, to no avail. Under Lowell's guidance the search began at Flagstaff in 1905. As the observations remained fruitless, Lowell continued to revise his calculations. His death, in 1916, came before his theories were verified.

The long search ended just thirty years ago, shortly after a new, thirteen-inch telescope was installed at Flagstaff. In January, 1930, the young astronomer Clyde W. Tombaugh used the new instrument to take a number of photographs of the star field surrounding the position predicted by Lowell. After a careful comparison of the plates, he discovered the planet on February 18, 1930—within five degrees of the calculated place (photos *below*). Announcement was withheld until March 13, 1930, to coincide with Lowell's birthday. His initials P.L. inspired the choice of the name Pluto, thus honoring him without breaking the tradition of using mythological designations for astronomical bodies.



ery photos of January, 1930, are shown, *above*. In
xposed on January 23, Pluto is seen beside arrow.



Pluto's shift to new position six days later (arrow, *above*) was proof that faint image was the long-sought ninth planet.

THE SKY IN JANUARY

From the Almanac:

Moon at first quarter: January 5, 1:53 P.M., EST.
Full Moon: January 13, 6:51 P.M., EST.
Moon at last quarter: January 21, 10:01 A.M., EST.
New Moon: January 28, 1:16 A.M., EST.

The earth reaches *perihelion* on January 4. This is the nearest approach of the earth to the sun in 1960.

For the visual observer:

A very unusual grouping of planets will greet the early riser this January. All major planets are in the morning sky and all are close to each other. At dawn on January 11, Venus, Jupiter, and Mars (in that order) will be seen rising in single file over a period of approximately ninety minutes, starting about three hours before sunrise (*see* illustration, *right*). Saturn and Mercury will follow the same path shortly thereafter, but they are so close to the sun on that date that they will be lost in its glare.

Mercury will be very low over the southeastern horizon and poorly placed for observation throughout January. It will be in *superior conjunction* with the sun on January 26 and will enter the evening sky on that date.

Venus will rise three and one-half hours before the sun on January 1, three hours before on January 15 and two hours before on January 31. Its magnitude will decrease slightly (from −3.7 to −3.5) in the course of the month, but nevertheless it will remain very brilliant.

Mars will rise about ninety minutes before the sun throughout January and will be found very low in the sky at sunrise. It will be seen only by those who have an unobstructed view of the southeastern horizon.

Jupiter, in Ophiuchus (magnitude −1.4), will be found to the northeast of Antares. It will rise ninety minutes before the sun on January 1, two hours and fifteen minutes before on January 15, and three hours before on January 31.

Saturn, in Sagittarius (magnitude + 0.8) will be lost in the glare of the sun during most of January. It will become slightly more favorable for observation as the month progresses. By the end of January, it will make its appearance about ninety minutes before sunrise.

For binoculars and small telescopes:

The following objects, appearing in the evening sky in January, may be seen with a small instrument (*see* map):

The Great Nebula in Andromeda, faintly visible to the naked eye as a hazy patch. This giant spiral galaxy is believed to resemble closely our own Milky Way. Its distance is currently estimated at two million light-years.

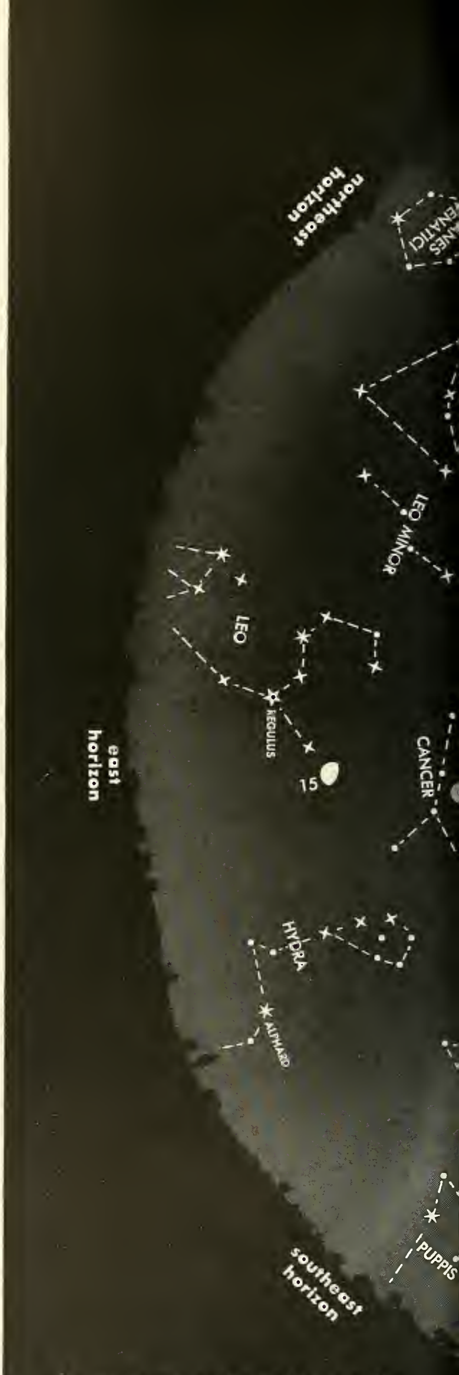
The Pleiades, a cluster of stars embedded in faint nebulosity. Under various names, the cluster appears in many legends of ancient and primitive civilizations.

The Great Nebula in Orion. This is one of the most beautiful gaseous neublae. Its fan-shaped structure is readily seen even with binoculars.

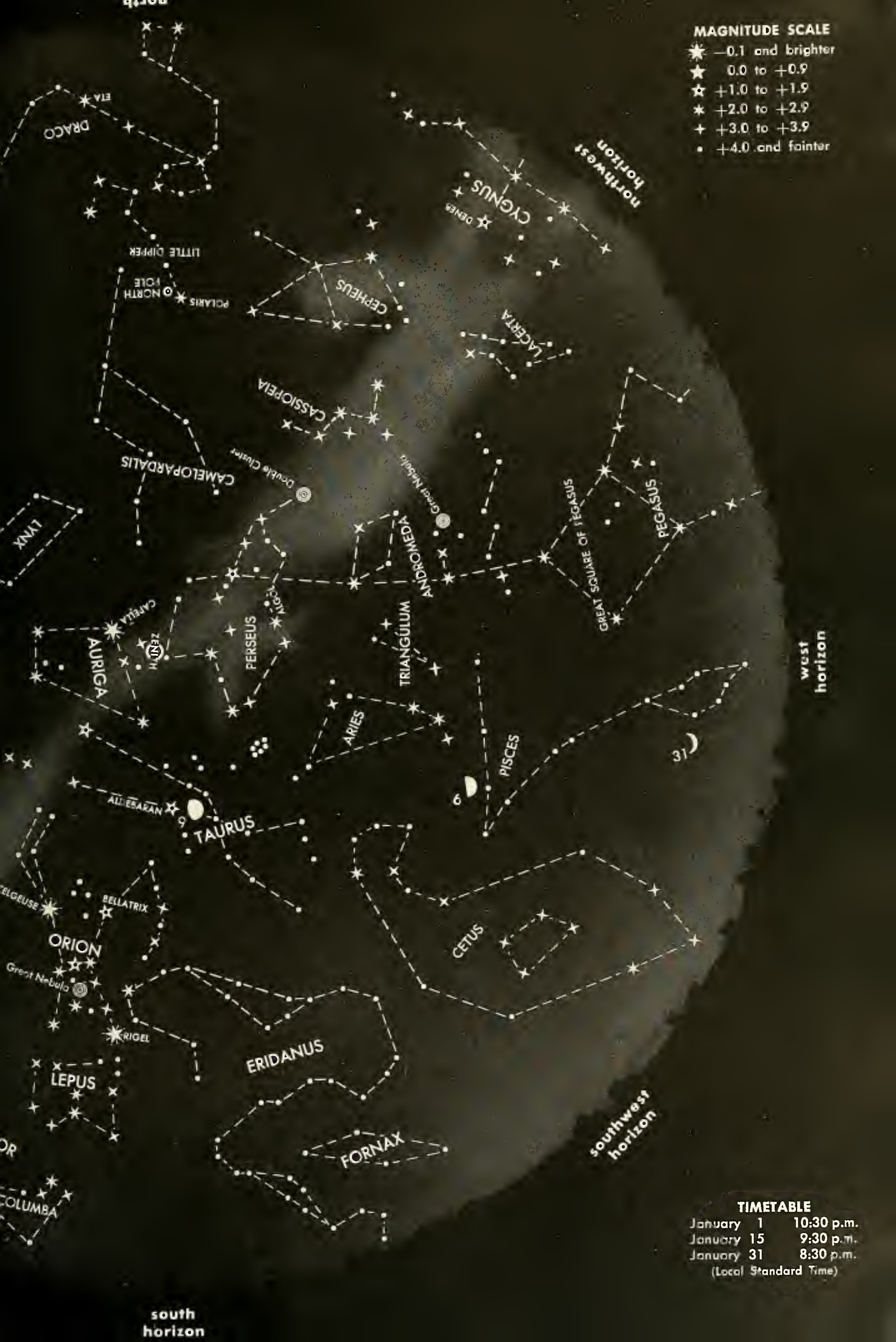
Praesepe (the Beehive), a loose aggregate of stars, characteristic of the type called an open cluster.

The Double Cluster in Perseus, a pair of well-defined, star clusters of almost equal size.

MRS. GOSSNER, who first studied astronomy in her native Belgium, came to this country after World War II to work at the Harvard Observatory. Astronomy Editor for NATURE Magazine, she continues in that role for NATURAL HISTORY.



To use this map outdoors, hold it in such a way that the direction you wish to face is printed at the bottom. The constellations depicted below the point marked "zenith" are visible in that part of the sky at the time indicated.


north
DRACO
ETA
LITTLE DIPPER
NORTH POLE
POLARIS
CYGNUS
DENEB
northwest horizon
CEPHEUS
LACERTA
CASSIOPEIA
Double Cluster
Great Nebula
CAMELOPARDALIS
LYNX
ANDROMEDA
GREAT SQUARE OF PEGASUS
PEGASUS
CAPELLA
AURIGA
ZENITH
PERSEUS
ALGOL
TRIANGULUM
ARIES
PISCES
west horizon
31
6
ALDEBARAN
9
TAURUS
CETUS
ELGEUSE
BELLATRIX
ORION
Great Nebula
RIGEL
ERIDANUS
LEPUS
FORNAX
southwest horizon
OR
OLUMBA
south horizon

MAGNITUDE SCALE

✸	−0.1 and brighter
★	0.0 to +0.9
☆	+1.0 to +1.9
✶	+2.0 to +2.9
+	+3.0 to +3.9
•	+4.0 and fainter

TIMETABLE

January	1	10:30 p.m.
January	15	9:30 p.m.
January	31	8:30 p.m.

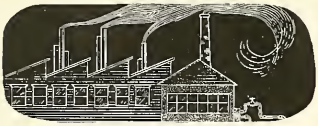
(Local Standard Time)

WASHINGTON NEWSLETTER

By RICHARD W. WESTWOOD

THE HIATUS between two sessions of the same Congress has a somewhat eerie character, as bills are suddenly left in a state of suspended animation. They may have been the subject of extensive hearing, may have caused acrimonious debate in committee, may have been passed by one or both branches of Congress, or may have been referred to a conference committee. No matter, when Congress packs up and departs, all action ceases.

At the conclusion of any second session of a Congress, of course, proposed legislation dies with the sound of the final gavel. Bills must start from scratch with a new Congress. But in the present case – a recess – bills may benefit by the momentum they gathered during the first session and, perhaps, finally win approval during the second.



Water Pollution

SEVERAL important pieces of conservation legislation are now awaiting the second session of the Eighty-sixth Congress, which thus far has not attained a notable record for action in this field. One bill concerns stream pollution, a problem that has plagued conservationists for many years. The Federal Water Pollution Act of 1956 authorized Federal grants-in-aid to speed construction of municipal sewage treatment plants approved by the states. The Administration and the Bureau of the Budget took a dim view of such grants, and proposed a cut of twenty-five million dollars from the forty-five million appropriated for the current fiscal year. There were indications, moreover, that no grants would be recommended thereafter.

Congress took a different view, and the House passed the Blatnik bill (H.R. 3610), which provides specific appropriation for grants-in-aid, by a vote of 255 to 143. The House approval was for an appropriation of one hundred million dollars a year for ten years to encourage pollution control. The Senate cut the appropriation by half in committee, but then voted 61 to 27 to approve an appropriation of eighty million. This difference in the two bills sent the matter to a conference committee, and there the issue reposed as the session ended.

Wilderness Legislation

ANOTHER measure enveloped in the between-session vacuum is the so-called "Wilderness Bill" (H.R. 1123). If one should be bold enough to attempt a brief description of this measure, one could say that it seeks to give a stronger status and protection than is now afforded to areas of outstanding wilderness significance within National Forests, National Parks, and Federal Wildlife Refuges. Few proposals have been given such extensive hearings, in the capital and throughout the country, as this one. Several volumes of testimony have been published, and the bill has been amended and compromised to accommodate not only a number of reasonable criticisms but even some that could be called unreasonable.

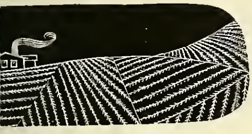
Opponents of the measure – and there are still a few – contend that it violates the principle of multiple use, particularly of national forest areas for grazing, lumbering, watershed protection, mining, and recreation. Opponents also contend that roadless, primitive, and wilderness areas within the national forests are already adequately protected by their classification in one or another of these categories by the U. S. Forest Service. Proponents deny this, pointing to the terms of the legislation itself and
emphasizing that presently designa
wilderness areas could quickly bec
unprotected by simple administra
order. The wilderness issue is an im
tant one to the nation as a whole,
physically and philosophically. The
was on the verge of being reported
vorably when the first session en
Now, early consideration has been pr
ised in the second session.

Park Programs

ALTHOUGH Congress appropria
funds to allow the National P
Service to continue its "Mission
program (which seeks to meet the p
able 1966 public demands upon t
areas), there was no final action on o
significant National Park legislat
The proposed Chesapeake and C
Canal National Historical Park m
some progress, thanks to a favorable
port by the House Committee on Inte
and Insular Affairs. However, the
was not cleared by the Rules Commi
in time for a vote in this session. Or
bus bills that would authorize a prog
to preserve certain remaining shore
parks on the Atlantic and the Pa
coasts, the Gulf of Mexico, and the G
Lakes, failed to come to hearing. I
vidual bills in favor of the Cape
National Seashore, the Oregon Du
National Seashore, and the Dunes
tional Shoreline Park in Indiana are
still to be heard. However, the la
area is already being prepared fo
steel mill and dredged for a harbor
its future as a park is definitely clou
The question of shore line preservat
is sure to be given consideration at
second session of Congress.

Insecticides

ssue with which Congress did ıe to grips was that of studying cts of economic poisons — es- insecticides with highly lethal es — on birds, fishes, and other wildlife. Many new poisons are d annually, and relatively little n about their side effects on hu- nimals, and the soil. Far more e research is essential, and the s approved two and a half mil- ars a year to conduct thorough this question.



Soil Bank

IER affirmative action concerned Conservation Reserve Soil Bank ı, under which land is devoted rvation use instead of to addi- rop production. Positive values is program already have been ıed, with wildlife populations ng as a result of more satisfac- itats. Congress granted the same as last year — three hundred and five million dollars — for the pro- lowever, the Soil Bank Act ex- ecember 31, 1960, so the issue of nuance will be an important and, ot, controversial matter during slative year.

Conference City

LLY, Washington is the conserva- n capital of the country for two First, Congress is the source ich all appropriations flow, and slative acts importantly affect . Second, Washington is the cen- dministrative programs. The ma- eral agencies charged with man- t and conservation of our natural es — renewable and non-renew- are in the Department of the In- nd the Department of Agricul- e Department of Defense is also ngly practicing conservation on nder its jurisdiction, and the the U. S. Army Corps of Engi- onsiderably affects conservation times, in the opinion of many ationists, negatively.

ington is also the headquarters alanx of organizations whose ma- cern is conservation. They in- he American Forestry Associa- merican Nature Association, an Planning and Civic Associa- efenders of Wildlife, National ence on State Parks, National ssociation, National Reclamation ation, National Wildlife Federation, Natural Resources Council of America, Nature Conservancy, North American Wildlife Foundation, Society of American Foresters, Wilderness Society, Wildflower Preservation Society, and Wildlife Management Institute. A number of other organizations are Washington-based and have a peripheral interest in conservation. Examples are the Chamber of Commerce of the United States, American Farm Bureau Federation, General Federation of Women's Clubs, National Grange, and others. Indeed, it is safe to say that more conservation luncheons, conferences, committee meetings, and strategy huddles are held in the nation's capital than in all the rest of the nation put together.

TYPICAL of such conferences was a gathering recently assembled by the U. S. Fish and Wildlife Service to consider two vastly different ornithological questions. One problem concerned the farm crop depredations, at certain times of the year, by blackbirds. The other dealt with the uneasy coexistence of the Navy's Early Warning Wing on the Midway Islands with the resident albatrosses.

Blackbirds, including the redwing and yellow-headed blackbirds, cowbird, and grackle, were described as periodically causing large losses in corn, rice, and other grain crops. The Fish and Wildlife Service found itself caught between farmers asking for controls, on the one hand, and the hard fact, on the other, that some of these species are protected under the terms of the Migratory Bird Treaty Act and the pacts thereunder with Canada and Mexico. The Service admittedly found itself inadequately supplied with information about control in trouble spots. It was also cognizant of the fact that, at various seasons of the year, the birds are immensely valuable in controlling insects. What the Service sought, therefore, was public reaction to the issuance of permits for control that would protect the controller in case other protected birds were accidentally destroyed. This seemed to be an academic issue, since no satisfactory method of control now seems to be available.

MUCH more dramatic is the problem on Midway. About one-third of the world population of Laysan albatrosses, considerable numbers of black-footed albatrosses, and sooty terns breed on Midway. Fish and Wildlife biologists have made several studies in an endeavor to devise some way in which the birds might be induced to change their habits

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NATUREGRAPH — San Martin, California

or, preferably, their choice of habitat. Although there have been no crashes or fatalities due to the gooney birds, as the Laysan albatrosses are known, there have been many collisions between soaring birds and the aircraft based on Sand Island, causing physical damage to the planes and, of course, destruction to the birds. Indeed, some of the pilots have taken to painting a picture of a gooney bird on their aircraft to record each strike, much as a record of each downed plane was made in time of war.

Oddly, the birds seem to enjoy any noise man can devise, and the more the better, so no harassment tried as yet have proved to be effective. Attempts have also been made, by changing the surface of Sand Island near the airstrip, to make it less attractive to the birds. At the same time, bulldozers are at work on another land area in the group, cutting swaths through the *Scaevola*, a thick-growing shrub. It is hoped that this land-clearing, which will afford the ground nesting sites and take-off runways the albatross prefers, will encourage the birds to transfer their affections away from Sand Island.

Banding has shown that young Laysan albatrosses go to sea and stay there for about four years, returning to their birthplace to pair and nest, or just to hang around as "unemployed" birds. It was apparent from the conference that, although the Navy will try other possible solutions, the service is just about convinced that elimination of the Laysan albatross from Sand Island over a span of seven years is the only answer.

SUCH meetings as this, and sma gatherings to discuss problems ing the National Park Service, the U Forest Service, and the other agenc are frequent. They provide "backgro material" for conservation groups. example of administrative collabora is found in the recent plan thro which the U. S. Army Corps of E neers and the Department of the terior would co-operate to prov recreational development on Fed reservoir projects rather than to des such possibilities by lack of co-ord tion and planning.

Truly, the "conservation front" Washington extends all the way f the hearing rooms of the House Senate office buildings and the le lative chambers of the Capitol to Department of Interior some tw blocks away, and across the Poto to the Pentagon. It is a complica broad, interesting, and challenging of our governmental structure, and that is of vital concern to the futur all Americans.

Legislative Forecast

THE tag "election year" will, of cou mark 1960. Thus, expediency in islation will become a factor to an greater degree than it was during past year. It is not felt, however, expediency should affect action on principal items of conservation leg tion now pending. Those are du emerge from their state of suspen animation at the second session, should move to final approval in 196

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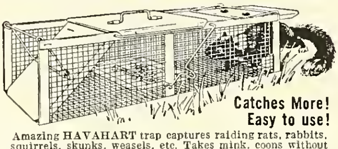

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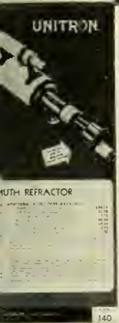
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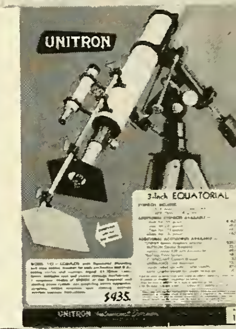
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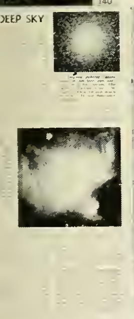
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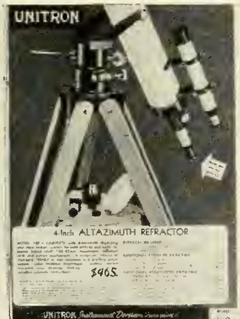
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WILDLIFE
MUSEUM

ILDLIFE OASIS IN ARIZONA

-shy animals come to drink at night

By Annette Richards Parent

HT ON THE DESERT has al-
ays presented to wondering
ı infinite variety that fades, in
; the sun rises. A daytime trav-
rough the deserts of North
a might marvel at the lack of
life. Yet, as soon as the sun sets,
teland comes alive.

nis arid land, where less than
hes of rain falls yearly, both
; and plants have had to adapt
emes of drought. To do this,
ve become water-hoarders. One
animals to save precious mois-
to avoid the hot sun, and their
daytime concealment accounts
for the apparently empty desert. At night, however, they emerge—from burrows, from under a sheltering jojoba bush (which also provides them with edible seeds and foliage), or from under paloverde or mesquite—to go in search of food and, of course, a supply of water.

In the southwestern desert, near Tucson, Arizona, a museum has taken advantage of this eternal search for water by arranging facilities for taking pictures of the desert residents. The Arizona–Sonora Desert Museum lies amid some 30,000 acres in Tucson Mountain Park—a game preserve and recreation area—where deep canyons and high mountains provide a variety of homes for desert life. The giant saguaro rises to heights of twenty to thirty feet, and creates a true cactus forest. Because there is little surface water in the area, the Museum sank wells and established pipe-fed water holes. At one such man-made oasis, a small building houses a photographic blind from which Museum members may take pictures of the varieties of wildlife that come to drink at night.

The blind has four windows, and is equipped with chairs for comfortable waiting. A fifteen-watt bulb burns twenty-four hours a day so that, even on moonless nights, watchers can see their quarry drinking a dozen feet away. Outside the blind is mounted a battery of "strobe" lights that can be fired simultaneously. Some of the pictures on these pages were taken at this blind, some at a similar water hole five miles away.

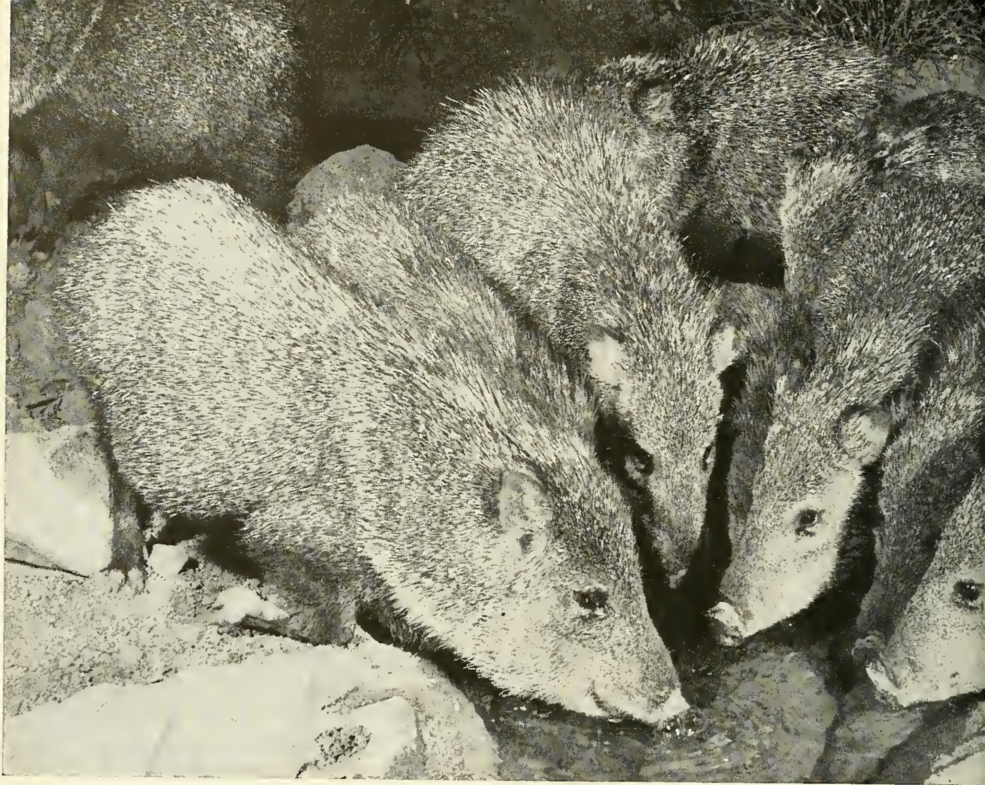
To these oases come representatives of most of the desert population. During the daytime, the pools are preempted by the birds, and become centers of flashing color and of movement. Mearn's gilded flicker, the home-builder of the desert, is a regular visitor. This handsome, foot-long bird plays a special role in its desert habitat. With its powerful bill, it digs holes in the tall saguaros, in its search for insects. These holes, in turn, become nesting sites for martins, sparrow hawks, flycatchers, or elf owls.

After night comes to the desert and the birds have left the water holes, the four-footed creatures move in. Rarest, perhaps—at least to a watcher—are the coyote, the gray fox, the ring-tailed cat, and the raccoon.

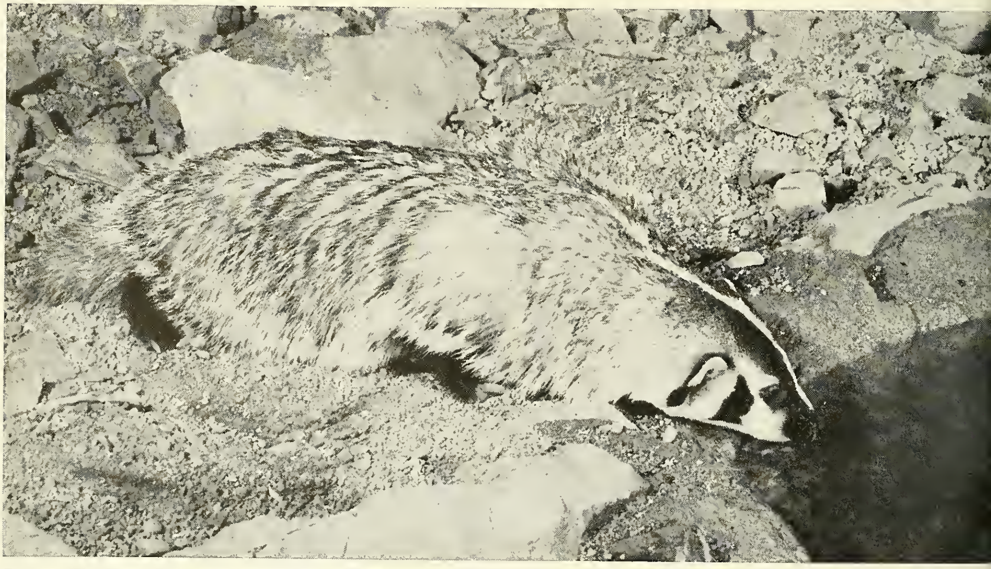
One of the most regular and exciting visitors to the water supply is the mule deer. This handsome creature is reddish in summer and blue-gray in winter. Its large ears and separately branched antlers distinguish it from its eastern cousin, the white-tailed deer. This purely western species stands three to three-and-a-half feet high, weighs from 125 to 200 pounds, and usually travels in herds. The mule deer's approach to a water hole is one

RAPHERS in blind, *left*, view
creatures at a man-made water
hole. Mule deer, such as the six-point buck, *above*, are among the visitors.

Mrs. Parent is a free-lance writer who lives in Tucson, Arizona. She is an enthusiastic reporter of life in the desert, and her work is familiar to regular readers of this magazine.



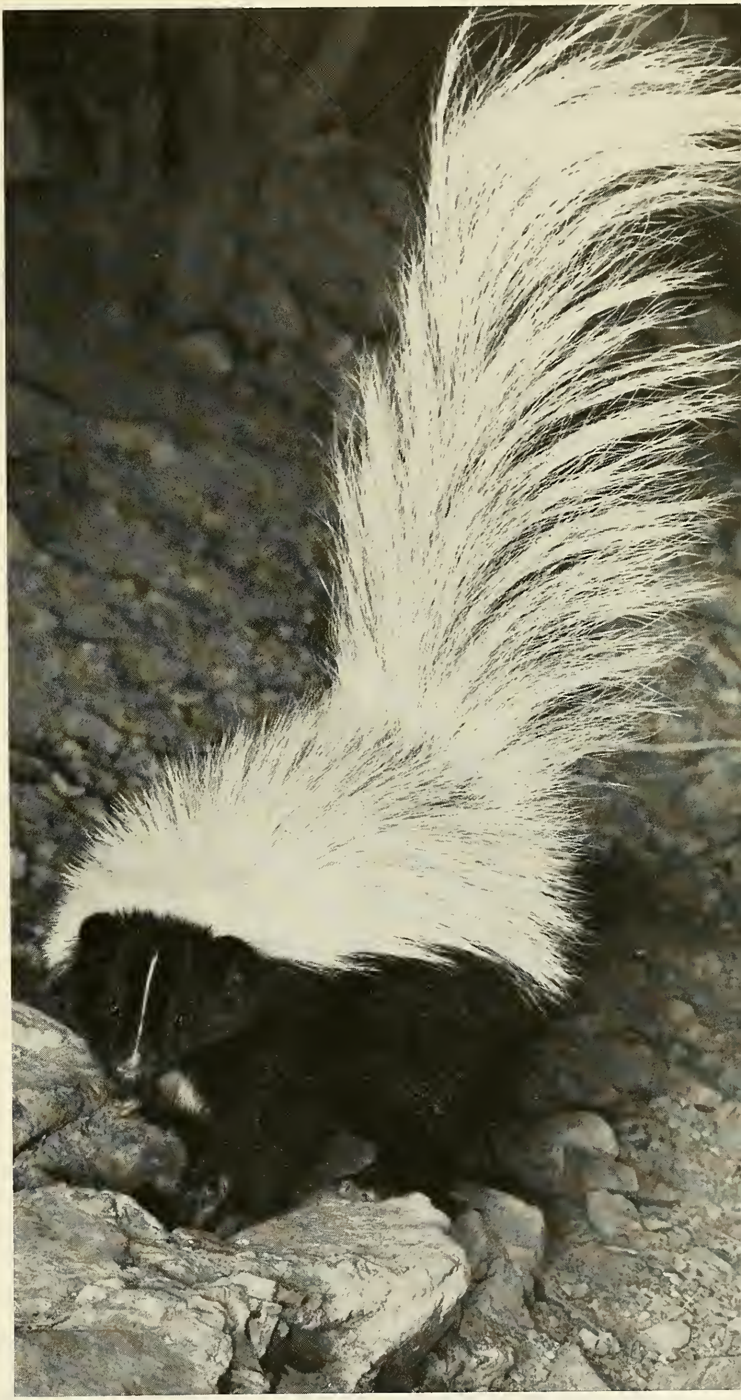
TUSKED JAVELINA, or peccaries, the fierce wild "pigs" of the Sonora Desert, usually travel in herds. Their approach to the water hole is a retreat signal for other wil Kneeling on stubby forelegs, *above*, a group drink noi



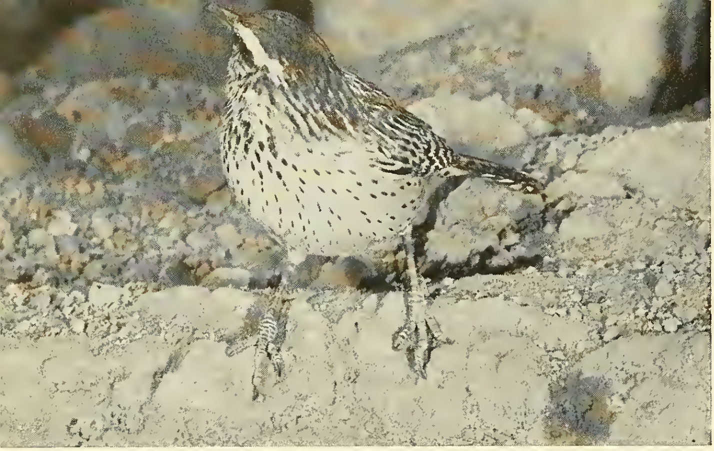
BADGER, *above*, is a member of the Family Mustelidae, to which belong the skunk and the weasel. Although usually a peaceful animal, the badger will give battle when it been cornered. Its short legs make it a powerful dig

ts and stops, of smelling and
ıg, of fearful anticipation and
'orays. Usually, the buck is the
drink. Gradually, he is joined
or two does. The moment the
lights go off, however, the deer
ildly into the sheltering dark-
ut deer are notoriously curious,
'ten they will freeze just outside
ng of illumination thrown by
ıall permanent light, watching
photographer adjusts strobe
until thirst sends them back to
ol again. Some nights, as many
y mule deer will visit a water
On another night, oddly, not a
one will appear.

IS same erratic pattern is fol-
wed by the javelina, or peccary
wild "pig" of the Americas. The
ıa, with its short, powerful tusks,
much like an Old World boar.
rizzled, sturdy beast, found only
extreme southern section of the
na Desert, ranges far down into
o and beyond. Often javelina



HOODED SKUNK's neck hair is usually spread out in a handsome ruff. A white line down its nose is an identification aid. It is not found north of Arizona.



Cactus wren, *above*, the state bird of Arizona, is a large member of its family. Its grass nest is built among the sharp spines of the cholla cactus.

Home-builder for other birds is the handsome gilded flicker, *above*. It was photographed at Museum's water hole, as was the wary desert sparrow, *below*.

travel in herds of three to fifty—ea
worms, insects, reptiles, nuts,
roots, but preferring the succu
fruits of various cactus plants.

In addition to tusks, the javel
carry another powerful deter
to interference in a set of musk gla
when they approach the water h
all other wildlife prudently leave
many as a dozen may cluster at
water's edge, getting down on t
calloused knees, grunting, blow
and lapping noisily. Occasionall
skirmish will break out, but eventu
the herd drifts off into the night
lowing the more timid animals
return to the pool.

The low-slung badger is ano
regular. A heavy-bodied, yellow-
cousin of the skunk and weasel,
also equipped with musk glands.
badger, a powerful digger, live
ground burrows that it excavates
the help of the extraordinarily
claws on its front feet. It prefers
less country, and can be found in
West from Mexico to Canada.

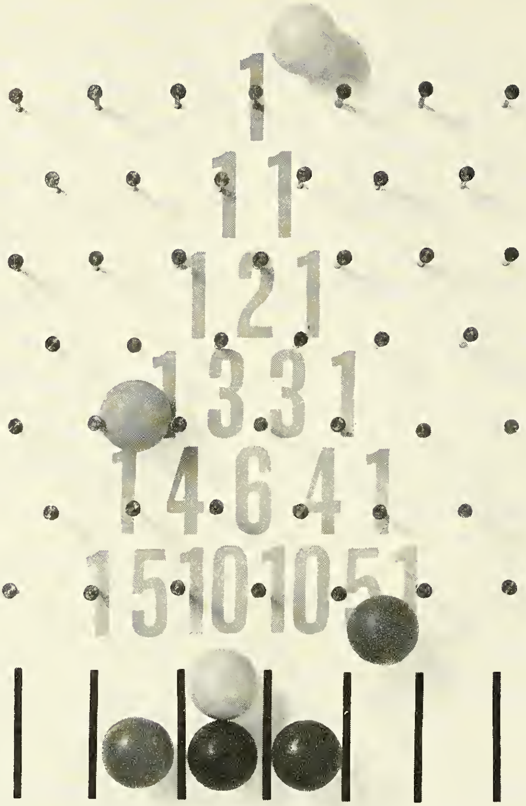
The beauties of the desert are
hog-nosed and hooded skunks.
though superficially similar in app
ance, the hooded skunk can
distinguished by the white line d
the center of its nose. In one
phase, the back of the hooded sk
is nearly entirely white—from its
to the tip of its plumelike tai
another phase, its back is black,
a pair of white stripes on each
Like the javelina, this skunk ra
south from the Arizona Desert.

At the right is the exquisite,
Arizona gray fox, capture
film as it ventured from some hi
canyon in nocturnal foray. This
eared fox of the saguaro forest h
remarkably well-furred tail, and
generally gray coloration is dram
cally accented with red. It is ra
seen in the daylight.

Perhaps the most memorable as
of water hole observations lies in
realization that an apparently ho
terrain has not drastically limited
kinds of life it embraces. Instead,
and animal communities have fo
advantageous relationships that
mit them to adjust to extremes of
and cold, famine and plenty, and
eternal lack of water.

Legs taut in anticipation, an Ari
gray fox, *right*, hunts in desert n

MATHEMATICS SERVING MAN



MATHEMATICS OF CHANCE: What are the chances that the top ball will fall into the left-hand slot? A trivial point? Not to a great mathematician. When the deeply religious Blaise Pascal answered a similar question to settle a gambler's argument in seventeenth century Paris, he gave mathematics one of its most important tasks—prediction. Using Pascal's famous triangle of numbers,* the probable number of times that a given event will happen by pure chance can be determined. In the 300 years since then, the mathematical laws of probability have helped establish the insurance business, enable scientists to predict the molecular behavior of gases, forecast the results of cross-breeding plants or animals, analyze the value of a new serum. The mathematical insight that made all this possible is now being applied to weather forecasting, psychological testing and public opinion research. Probability has become a science that calculates in advance the chances of success of an untold number of events for man's benefit. IBM®

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*For example, the third line from the tip of the triangle tells us there are four different ways two coins can land: the chance of both falling heads up is 1 in 4; of one head and one tail, 2 in 4; and of two tails, 1 in 4.

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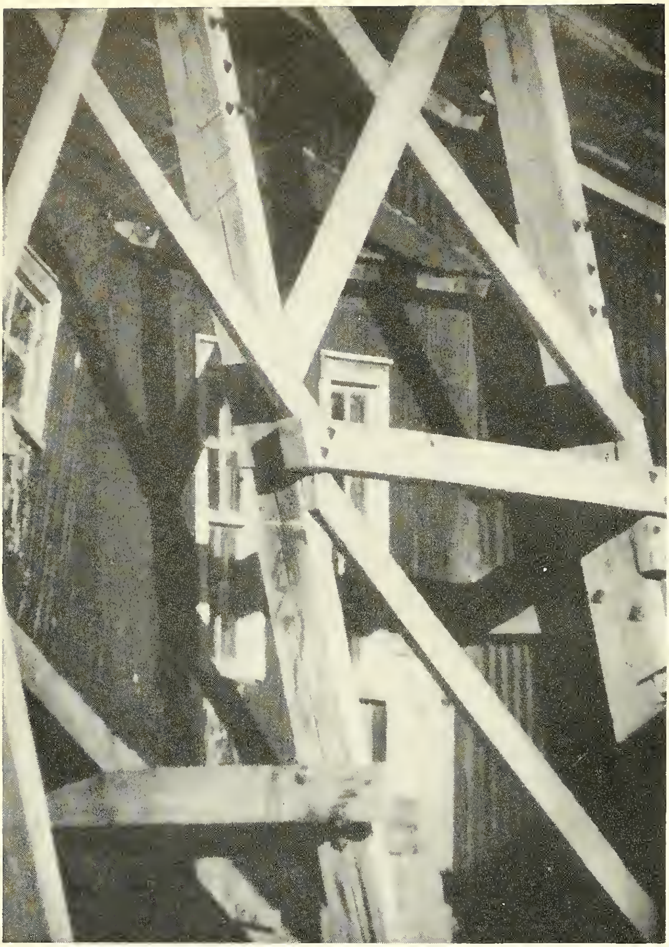

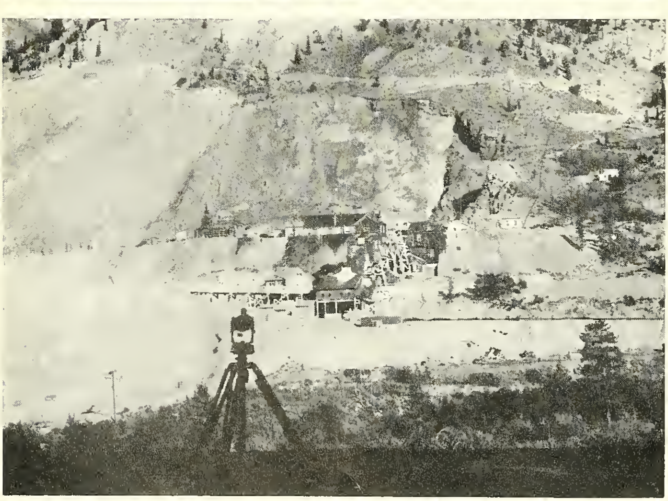

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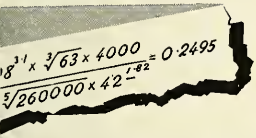

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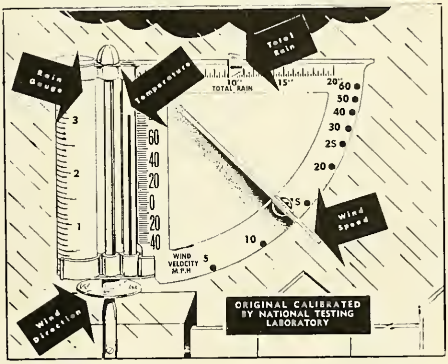

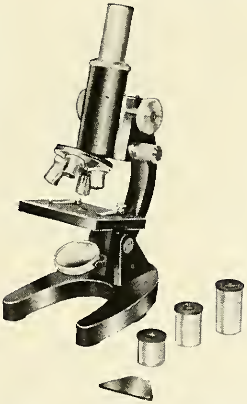

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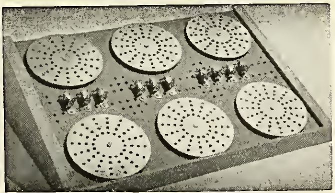

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ARTICLES

THE SKY IN REPLICA *Joseph M. Chamberlain*

WAYS OF THE WOLVERINE *Peter Krott*

ART OF THE ESKIMO *Edward M. Weyer*

WINTER WOODS *Jack McCormick*

ON THE COSMIC BRINK *Franklyn M. Branley*

DEPARTMENTS

THE ANTHROPOLOGY OF EVOLUTION *Robert L. Carneiro*

SKY REPORTER *Simone Daro Gossner*

NATURE AND THE MICROSCOPE *Julian D. Corrington*

COVER: The Eskimos, despite—or perhaps because of—their harsh, hur existence, have created a unique art form in their sculpture, in which the c and its animals predominate as subjects. The hunter on this month's c photographed by Lee Boltin, was carved by Eshaloak, from the Port Har area of Hudson Bay; his quarry, a seal, by Kannieguk from Repulse Bay

NATURAL HISTORY is indebted both to Nelson R. Perry, the private colle and to the Canadian Department of Northern Affairs and National Resou for making available the examples of Eskimo art shown on pages 34 t

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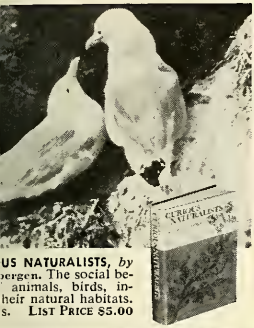

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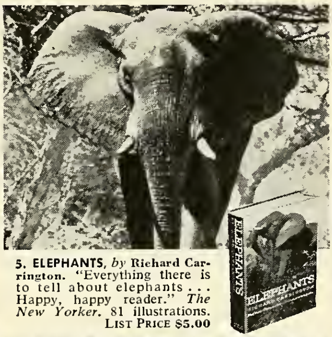

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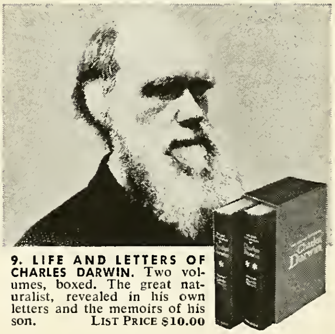

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Reviews

THE ANTHROPOLOGY OF EVOLUTI

Reviewed by **Robert L. Carn**

The Evolution of Culture, by Leslie A. White. *McGraw-Hill, $10.00; text edition, $7.50 x 1-1378 pp.*

Publication of *The Evolution of Culture* marks the fruition of ten years of labor by Leslie A. White, Professor of Anthropology at the University of Michigan. In order to appreciate the significance of this work it is first necessary to know something of the climate of opinion out of which it arose and to what it was a reaction.

Few persons outside the field of anthropology are aware that the concept of evolution, which has become almost the guiding principle of most other natural scientists, has been for decades rejected by cultural anthropologists. But it had not always been thus. Under the influence of such men as E. B. Tylor, Lewis H. Morgan, and Herbert Spencer, ethnology began with a strong evolutionary outlook; and evolutionary anthropology made many fruitful and enduring contributions to our knowledge of the origin and development of human institutions. For example, the general sequence of events by which man advanced from a hunting, fishing, and gathering economy to a simple agricultural mode of life—and then on to a complex civilization—was established by evolutionist writers by the end of the nineteenth century.

Some of the early evolutionists did, however, commit errors of a sort characteristic of a science in its pioneer stages. An instance of this is Morgan's now-discredited theory that primitive promiscuity and group marriage preceded monogamy in the history of human marriage. This evolutionary sequence probably would never have been proposed by Morgan had more information been available to him concerning the marriage practices of the most primitive peoples then extant.

By the middle of the 1890's, a movement had begun, under the leadership of Franz Boas, to expunge from ethnology those theories of the early evolutionists that, like Morgan's views about the succession of forms of the family, had proved untenable. But the movement led by Boas did not stop at pointing out errors in the early evolutionists' schema: At its height in the 1930's, it had engulfed almost all professional anthropologists, who tended to turn their backs on virtually every kind of evolutionary formulation. Instead, anthropologists concerned themselves largely with the facts of their own field work, or with studies of distributions, diffusion, and the like.

It was in this antievolutionary tradition that White himself was trained. However, as he tells us in his preface, he could not maintain his allegiance to it: "The author absorbed the antievolutionist doctrines of the Boas School as a graduate student. But as he began to teach, he found, first, that he could not defend this point of view, and later that he could no longer hold it."

Thereafter, White began to recultivate the long-neglected garden of cultural evolution. In 1943, his first major article on the subject, "Energy and the Evolution of Culture," appeared in the *American Anthropologist*, and its publication may be taken as the turning point in professional opinion regarding cultural evolution. Today, even though evolutionary formulations are still modest and tentative, there is a growing confidence that, as the evolutionary approach is applied more extensively, a correspondingly greater understanding of the enormous body of anthropological data will arise.

While a few other anthropologists—notably the late V. Gordon Childe in England and Julian H. Steward in the United States—have played a part in redirecting attention to cultural evolution, the resurgence of interest in this field has been due in large measure to Leslie White.

The work under review, although written and published to stand alone, is intended also as the first of three volumes, which together not only will survey man's cultural development from the Paleolithic to the present, but will also extrapolate current trends into the future. As White tells us: "The present volume will take the reader to the collapse of the Roman state. We propose to follow this work with a study of the Fuel Revolution and its institutional concomitants. And, finally, we hope to project the curve of a million years of cultural development in a modest way and to a limited extent in a third volume on *Recent Trends and Future Probabilities:* 1958-2058." With this as background, let us see manner of book White has br forth. Summarized briefly, *The E tion of Culture* can be described general treatise on the structure, tion, and evolution of human soc tural systems. It is *not*, as some surmise, an episodic account o *history* of man's cultural achieven In fact, throughout most of the persons, places, and events are al lacking. Rather, the work is inte to be an analysis of the princ processes, and mechanisms of cu evolution. Its focus is on the ge course of development of huma

Stages in the evolution of culture are indicated, *l. to r.*, for several elements: means of subsistence, sources of energy, architecture, and exchange or trade. The civilizations shown are, from bottom to top, Paleolithic, Neolithic, Bronze Age.

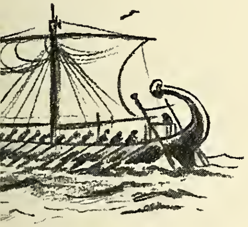
nd on explaining this progres-
terms of the forces that White
; gave it impetus and direction.
ite its title, however, evolution
ot dominate the volume to the
that one might suppose. Part
ntitled "Primitive Culture" and
ing nearly three-quarters of the
is essentially a presentation of
f the more important customs
stitutions of primitive society,
analysis of how they operate to
the continuous struggle of all
s for survival and security. This
of the book is concerned more
e origin, structure, and function
things as kinship systems, the
of labor, the clan, and the in-
oo, than it is with tracing their
ment over a million years of
l history. It is not until Part
The Agricultural Revolution and Its Consequences," that the exposition becomes fully evolutionary.

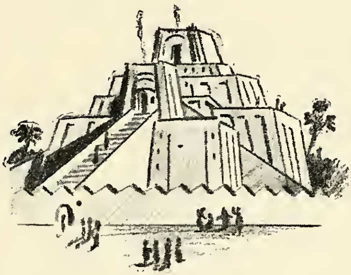
THE opening chapters contain a forthright statement of White's views regarding the place of culture in nature, and that of the science of culture in the system of the sciences. These views merit close attention. One of White's major premises is that cultural phenomena, as part of the natural world, must be interpreted from the viewpoint of science:

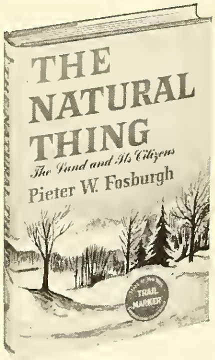
"Uniformities, regularities, and continuities are found everywhere, in systems of all kinds. Custom is merely the name of these attributes within the class of *cultural* systems. The concept *custom* thus serves to place sociocultural systems in a context as broad as science itself. . . ."

Furthermore, "The problems of the social scientist in general and of the culturologist in particular do not differ in nature from those of scientists in the physical and biological realms. The basic problems of all science are those of structure and function, of differentiation and integration. The astronomer's objective is to discover the structure of the cosmos, galaxies, star clusters, and the stars and to interpret their behavior. The physicist is concerned with the structure of the atom and the interrelationship of its parts. The biologist wants to know how living things are constructed and how they behave. Like his fellow scientists in other fields, the culturologist analyzes the structures of cultures in general and of social systems in particular and interprets their behavior."

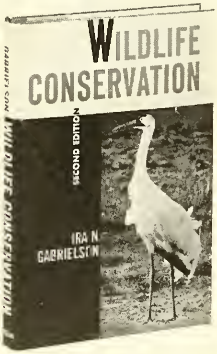
It follows that human behavior and institutions, like other spheres of na-







For ten years Pieter Fosburgh was editor of **The Conservationist**, official publication of the New York State Conservation Department. During that time he wrote a number of essays, which he has expanded and revised, which together with a number of new essays form the content of this book. With humor, humanity, and insight he writes with a fresh attitude towards conservation and a real appreciation of the problems and personalities involved. The result is a delightfully persuasive book which can be opened at any page and read with pleasure and profit. $5.00



To the second edition of this definitive book Dr. Gabrielson has added an important new chapter on the effect that changing practices in farming have had on the present impending scarcity of wildlife. It is in the interest of farmers, he makes clear, to avoid destruction of this valuable resource. All the material has been brought up to date and Dr. Gabrielson's approach remains clear, practical, and thorough so that **Wildlife Conservation** continues to be the most comprehensive volume in its field. $5.50

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ture, are subject to natural laws: "The culturologist wants to work out the laws of behavior of cultural systems . . . just as the physicist has worked out laws for falling bodies."

White makes a convincing case for the primacy of technological factors in determining the form of society. ". . . a social system," he writes, "might well be defined as the way in which a society makes use of its particular technology in the various life-sustaining processes: subsistence, protection from the elements, defense from enemies, combating of disease. . . ."

While the technological system of society is viewed as comprising both tools and energy sources, White believes that ultimately the utilization of energy is the dominating fact in cultural evolution. He expresses the relationship between energy and cultural growth in the form of a law:

"*Culture advances as the amount of energy harnessed per capita per year increases, or as the efficiency or economy of the means of controlling energy is increased, or both.*"

DESPITE the importance he ascribes to the use of energy, White is not a "reductionist": that is, he does not hold that cultural phenomena are to be interpreted primarily in terms of physical, biological, or psychological factors. On the contrary, he again defends the position he has vigorously championed elsewhere: culture constitutes a distinct level or class of phenomena, and cultural phenomena are to be explained in terms of other cultural phenomena. Thus, if the Chinese loathe milk (a cultural fact), this is to be explained not in terms of any racial peculiarity or psychological tendency of the Chinese, but in terms of certain other cultural facts of Chinese society and history. It is this approach to the study of culture that White calls "culturology."

White proceeds to examine a number of practices and institutions of primitive societies both in regard to their internal workings and their contribution to the workings of social systems as wholes. In the reviewer's opinion, this part of White's work is one of the best introductions to human social organization to be found in the literature of anthropology. It is clear, penetrating, and illuminating. The following passage is typical of the way in which White seizes upon a relationship only dimly apprehended or vaguely expressed by other writers, and produces an enlightening and far-reaching principle.

"The effectiveness of a group in the struggle for existence and survival depends both upon its size and upon its solidarity. These factors are variable and stand in an inverse ratio to each other. Other factors being constant, the degree of solidarity varies inve with the size: the larger the group less the solidarity: an intensificatio solidarity would mean a diminutio size. The relationship between size solidarity with reference to the effec ness of the co-operating group ca expressed with precision in the fo ing simple formula: $E = Sz$ x where E stands for the effectivene the co-operating group; Sz, for and So, for *solidarity*. If the degre solidarity remains unchanged. an crease in size of the co-opera group would make it more effecti the struggle for existence. If ever, the group lost through dimin of solidarity as much as it gained increase in size, the net result woul zero; it could even lose if it suff more from a weakening of solid than it gained by increase in size. desirable goal of social evolution, the standpoint of success in the petitive struggle for existence, is t fore *increase in size without los solidarity*. But since the factor of darity may vary also. we may form the following generalization: *ever ciety tends to behave in such a wa to achieve that balance between and solidarity that will give it the m mum effectiveness in carrying o life-sustaining activities.*"

DR. CARNEIRO, an ethnologist o the staff of THE AMERICAN MUSEU is a specialist on South Americ

FOR decades, anthropologists tended to classify each other a longing to a historical, a functiona or an evolutionary school. Membe the historical school studied seque of events, which they dealt with as ticular and unique. Functionalists cerned themselves with the ways cultural elements functioned in the cieties they studied. Evolutionists voted their attention to tracing development of significant cult forms over time. While this classi tion is something of an oversimpli tion. persons identified with a partic school have tended to work within limits of theory and method chara istic of that school. Anthropologist the functionalist school have lar been indifferent to problems of the tory and development of human i tutions. They have studied intensi how societies work within a na range of time, but have not turned t attention to examining how and large-scale changes in human soc occur. Accordingly, the belief has gr that evolutionism and functiona were antagonistic and even mutually clusive. White, an evolutionist *par cellence*, destroys this illusion. Not

reconcile evolutionism and
lism as *approaches*, the sub-
his work makes it clear that
and function. as *processes*,
entail one another. Changes
oughout an entire social sys-
an initial innovation precisely
here is a *functional* relation
l its component parts. That is
ecause all parts of the system
d more or less closely to one
When. by inner dynamics of
the technological aspect of a
ianges, it thereby brings about
of successive transformations
iately affect every part of the
Cultural evolution is nothing
ı this process writ large.

ntioned, the second part of
e's work deals with the inven-
riculture, and with the revolu-
occurred in man's economic,
olitical, and religious institu-
result. Here, one chapter de-
processes and steps by which
Paleolithic bands were trans-
ito complex, civilized states.

iere that White concentrates
is evolution. Especially impor-
e reviewer's opinion, are some
s remarks about the sequence
and effect that led from the
ginnings of agriculture to the
ivilization. Traditionally, an-
ists have told this story some-
ollows: by making it possible,
ically, for a man to produce
l than he and his family could
agriculture "automatically"
to surpluses of food. Once
pluses existed to draw upon,
idividuals ceased food produc-
levoted their time and energies
› the elaboration of arts and
olitical organization, and re-
istitutions—in short, to build-
zation.

ifficulty with this traditional
s White points out, is that
ricultural peoples exist today
the tools and the time to pro-
urplus of food—and therefore,
eory runs, to go on to bigger
er things—yet these peoples
no food surplus at all and per-
taying simple! Evidently, the
means of producing an agri-
surplus are, by themselves, in-
to bring such a surplus about.
l factors—economic incentives
especially, political and mili-
pulsion—seem to be necessary
food surplus, with all its social
nces, will emerge.

ve already noted that White is
interested in the sequence of
evolution of any particular
region of the world: instead,
rn is with the evolution of culture *as a whole*. In pursuing this course of universal evolution White takes pains to avoid the pitfalls attributed to the early evolutionists. For example, he is careful to state that no particular society has to go through any fixed series of stages. That the Bantu tribes of Africa went directly from a Stone Age to an Iron Age, skipping a Bronze Age, contravenes nothing. It is only in the evolution of culture as a whole that a Bronze Age necessarily precedes an Iron Age. The process of diffusion renders it unnecessary for each individual society to recapitulate every stage of the development of culture as a whole.

When he does refer to the culture histories of specific peoples, White neither ignores nor minimizes their differences. He notes that, in addition to diffusion, different environmental conditions may give rise to variations in the course of development of particular societies. In discussing the origin of agriculture, for example, he writes:

"We are still faced with such questions as, 'Why did agriculture begin, in the Old World, about 8000 B.C. rather than 50,000?' and 'Why did it begin where it did rather than in other places?' We must look to environmental—climatic and physiographic—factors . . . for the answers to these questions." This recognition of the influence of particulars raises no theoretical difficulties in White's view: ". . . the culturologist is trying to formulate laws of behavior of cultural systems in general. Like the physicist, he wants valid universals. If one wishes to deal with particulars, with particular cultures or particular falling bodies, then allowance must of course be made for particular conditions in each instance."

THOSE who have followed White's writings on cultural evolution, and have looked forward to the publication of this work, may find in it less in the way of evolutionary formulations than they had expected. They may also feel that, while the contrast presented between primitive society on the one hand and early civilization on the other is most enlightening, the process by which the transformation from one to the other took place might have been discussed in more detail. The reviewer suspects that much of this will yet appear in the still-to-be published second volume of the trilogy.

But let no one think that the present volume cannot stand alone: it most certainly can. Indeed, it is a work that will richly reward anyone seeking to go beyond facts to interpretations. As an introduction to human societies as working systems and as an exposition of the motive forces underlying the great changes in the history of human culture, no other book is in the same class.

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THE SKY IN REPLICA

lel solar systems, once clockwork, are optical projections today

By Joseph M. Chamberlain

CHINES designed to show the relative motions of the sun, the moon, and the planets have been constructed ision since the beginning of the Christian era—and, ossibly, at even earlier dates. The first of these ical models in modern times was that built by Chris- ygens (1629–95). Huygens, the Dutch philosopher thematician, solved many of the mathematical prob- volving the relative motions of the planets, which entially the same problems that must be solved for r trains of similar instruments today. In England, a of Huygens' type was built for Charles Boyle, the Earl of Orrery (1676–1731), name "orrery" is still applied models of the solar system. machines usually consisted of s of globes, each representing bject in the solar system. The supported by metal rods, were ated by gearing at a central l. Some elaborate orreries dem- ed the planetary satellites as roperly relating the satellites' s to those of the planets. The xity of the latters' gear trains dily be appreciated.

Rittenhouse orrery—first in America.

of the most elegant of these or- vas on exhibit for several years els Planetarium of the Franklin e in Philadelphia. Known as enhouse orrery, it was built for the College of Philadelphia in part of the eighteenth century. remarkable device, accurately nting as it did the Keplerian of the planets. Both the Fels rium and the Buhl Planetarium and Institute of r Science in Pittsburgh today exhibit the modern part of these orreries, the so-called "planetarium" M. Sendtner of Munich. In addition to representa- f the planets, Sendtner's planetariums have the ad- that observers may look through one glass surface nclosing sphere and, on the opposite surface, see the their characteristic formations with the planets in and changing locations among them.

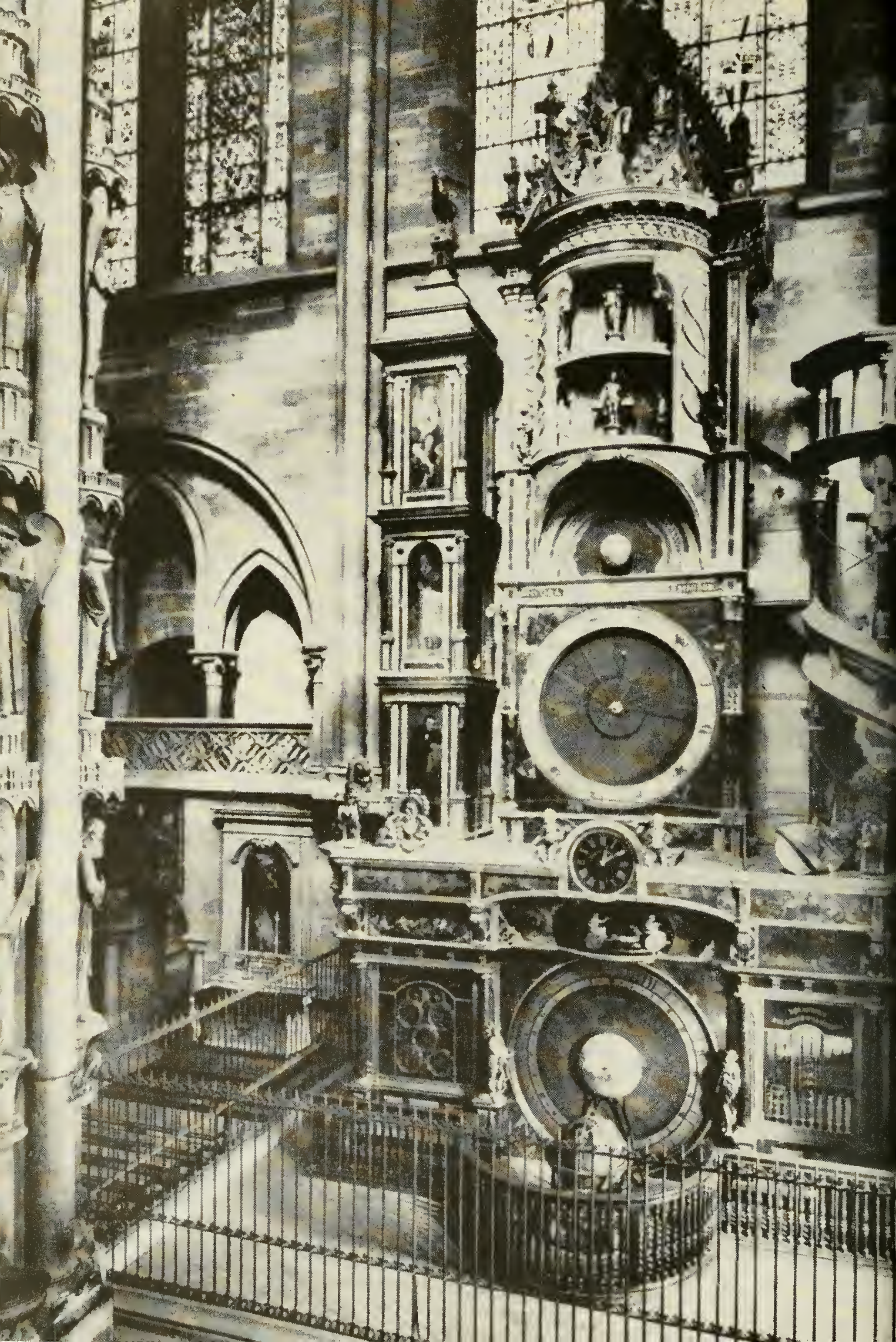
another variation to the orrery or planetarium was nstructed in 1913 for the Deutsches Museum in . A model of the solar system according to Coper- ts distinguishing features were its size and its earth tion. Attached to the center of the ceiling of a room forty feet in diameter was a "sun" globe, ten inches eter and containing a light that provided illumina- the entire room. Mercury, Venus, the earth, Mars, , and Saturn were represented by balls with diam- om about an inch and a half to about eight inches. They moved around the sun with speeds proportionate to their natural velocities (the earth, for example, completes a "year" in about twelve minutes).

Earth orientation was achieved by mounting a single-passenger carriage at the point where the ball representing the earth was attached. This carriage moved around with the earth. An observer riding in it, and seeing the planets through a periscope as lighted by the sun against a background of constellations painted on the walls of the room, could readily appreciate the Munich orrery's similarity to our own solar system. In effect, he saw an artificial sky that imitated the skies as seen from the earth. Of course, all comparative sizes and distances were distorted, and only one observer at a time could ride on the earth carriage. Unfortunately, the Munich orrery was destroyed during World War II. The American Museum-Hayden Planetarium and the Morehead Planetarium at Chapel Hill have similar models, but without the carriage-and-periscope arrangement.

Another type of planetarium gives a somewhat superior reproduction of the skies to a few more viewers. One of the oldest examples is known as the Gottorp Globe. Finished in the 1660's, it was eleven feet in diameter, weighed three and a half tons, and was so constructed that twelve persons could enter it, stand on a platform within it, and see the sky as viewed from the earth, rather than from space somewhere beyond the earth. The Gottorp Globe had a typical map of the sky on its inner surface, and many stars were represented. Originally driven by water power, it rotated once every twenty-four hours.

Before the start of World War I, Dr. Oskar von Miller, creator and director of the Deutsches Museum, approached the Carl Zeiss firm in Jena regarding construction of a planetarium that would show the movements of the heavenly bodies, on the interior of a hemispherical dome, in the same manner as they appear to an observer on the earth. The first idea was to represent the stars by small electric bulbs attached to the dome, while the dome rotated around an axis parallel to the earth's. The sun, moon, and planets were to be represented by illuminated disks, driven by suitable gearing in such a way that the orbits of the objects would be demonstrated. It soon became evident that it was impossible to solve the problem in this manner, and the outbreak of World War I then put a stop to the work.

Dr. W. Bauersfeld, of the Zeiss works, is credited with the suggestion that the problem be solved by means of projectors. "The great sphere (the planetarium dome)," he



. “shall be fixed; its inner white surface shall serve projection surface for many small projectors which be placed at the center of the sphere. The reciprocal ons and motions of the little projectors shall be onnected by suitable driving gears in such manner he little images of the heavenly bodies, thrown upon xed hemispheres, shall represent the stars visible to ıked eye, in position and motion, just as we are accus- l to see them in the natural clear sky.”

ᴇʀ the War, work was begun once again. In August, .924, after nearly five years of design and construc- the first modern planetarium instrument was pro- . The illusion of reality surpassed the expectations of Miller and even of the Zeiss people themselves.

e prototype instrument was limited in latitude motion ad only one spherical star projector, but these faults soon corrected. The dumbbell-shaped device that ince become synonymous with popular astronomy- ing was designed and put into production. Twenty- f these later models were built; most of them were led in Europe, and six have been erected in the United . The projection apparatus is about twelve feet long, a large globe at each end. Each globe contains pro- s for the fixed stars, one for the Northern Hemisphere sky and another for the Southern.

e main structure, containing all the projectors, is ted to turn independently about any one of three axes. it may turn about an axis parallel to the polar axis e earth. When this motion is used alone, the effect is nsport the images across the dome in exactly the same hat the daily rotation of the earth apparently moves al bodies across our sky each twenty-four hours.

ond, the machine may rotate about an axis perpen- ır to the plane in which the earth moves about the sun. out other motions in use, the effect of this is to swing orth Pole of the sky around the circle that it makes 26,000 years in the course of the precessional “wob- ” of the earth's axis. Thus one can, in effect, go ward or forward in time. For example, the lecturer can e instrument back some 5,000 years to 3000 B.C., when Draconis was our “North Star.” Or, by putting the ment ahead some 12,000 years, he can show Vega ing the North Pole of the heavens, and the Southern visible from the latitude of New York.

ally, the instrument embodies a horizontal axis ted from the east to the west. Rotation about this axis orts the images on the dome as if the viewer of the were traveling along a meridian of the earth from to pole. This motion is used to demonstrate the ged appearance of the skies from different latitudes, at one may observe the apparent movement of sun, , and stars from the North Pole or, traveling south, se the Magellanic Clouds, Canopus, and the Southern as they are seen below the Equator.

e slides for the star-field projectors are pieces of r foil with a small, round hole punched in them for of the stars. These punchings vary in size according e brightness of the real stars they represent. Nearby ts, such as the planets, the sun, and the moon, which ır to move against the background of the stars from day to day, are represented by separate projectors having independent motion on the main part of the machine.

SBOURG CATHEDRAL's astronomical clock built about has mechanism for calendar changes and planetarium.

STAR GLOBE at bottom of clock, *opposite,* shows machinery for precession revolution covering 25,800 natural years.

The prime movers for the machine are small, three-phase, alternating current motors; reversal of phase accomplishes reversal of direction. Transmission and interconnection are accomplished by gearing. Motions that are additive are joined through planetary transmissions. The motions and lamp circuits are all controlled from a switchboard in a lecturer's stand near the wall of the room.

TODAY, the United States contains ten major planetariums. Six of these—in Chicago, Philadelphia, Los Angeles, New York, Chapel Hill, and Pittsburgh—are Zeiss projectors. Two—at Flint and Colorado Springs—are instruments produced by the Spitz Laboratories, of Yorklyn, Delaware, and two—in San Francisco and Boston—were constructed specifically for previously established museums according to their *own* engineering specifications.

All ten share several physical characteristics: each produces a highly realistic artificial sky in which can be demonstrated diurnal and annual motions of the earth, latitude change of the observer, geocentric motions of the naked-eye planets, and the 26,000-year precessional cycle of the earth's axis of rotation. The domes vary in size from fifty to seventy-five feet and the seating capacities range from about 250 to over 800 persons. In each, the projector is the central attraction in an astronomical museum, which in most instances is a part of a larger organization. All cater to public audiences, and all—but to a widely varying extent—accommodate school and youth groups. Topical demonstrations of an astronomical nature are presented daily, with a change of theme monthly or bimonthly. Each is essentially non-profit in its legal structure, and

Modern orrery uses track-mounted models to show planetary motion. In time exposure, *above*, orbits of the six planets nearest the central "sun" can be seen. Inside orbit is Mercury's. Beyond lie Venus, Earth, Mars, Jupiter, Saturn.

most operate with subsidies or other support from a board of trustees or a city-related management board. None has a profit motive beyond the healthy goal of fiscal solvency, and all (except for the Air Force Academy installation) charge admission fees, though not for all visitors.

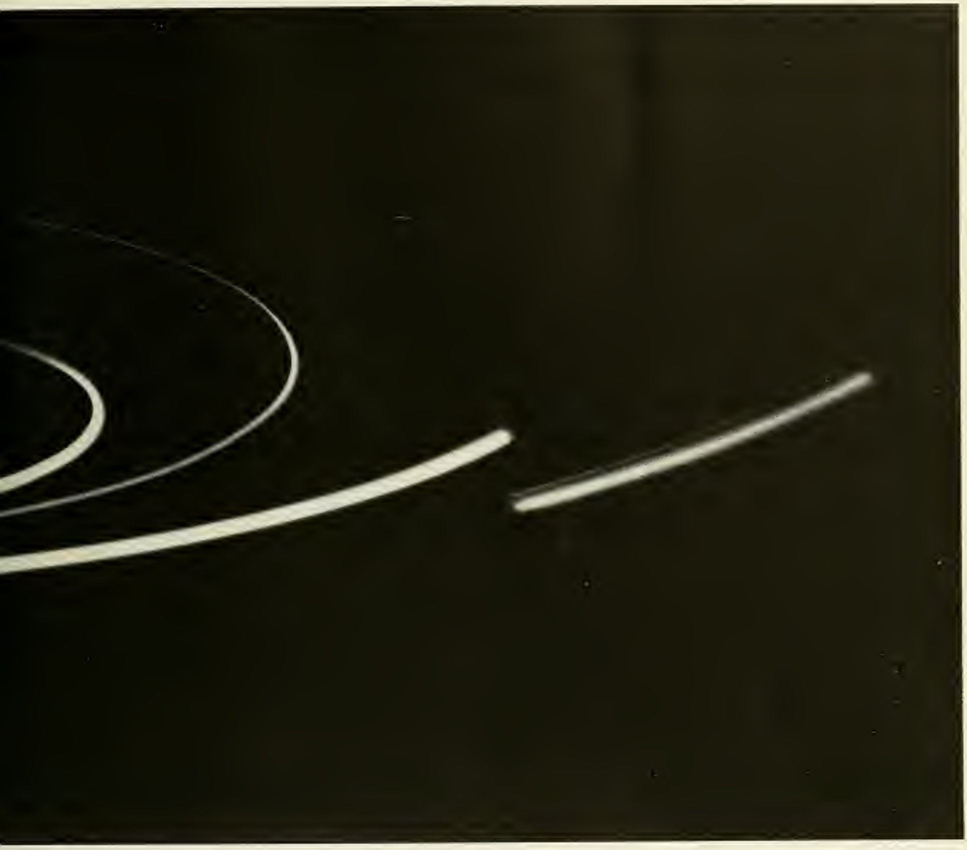
Over a hundred and eighty smaller planetariums have been installed in colleges, high schools, museums, and private homes across the country, in domes with seating capacities of twenty to one hundred persons. Many are used to supplement astronomy instruction in the schools, and may be utilized regularly for scheduled classes. Others are used much in the manner of the larger units, but on a smaller scale. Some have been so well planned and so expertly administered that their value within their home communities may be said to rival that of the major installations.

What of the "homemade" pair? Late in the 1940's, it was decided to establish a planetarium in San Francisco. Funds were raised by the California Academy of Sciences for the purpose, beginning with a gift of $200,000 from the estate of Alexander F. Morrison. A Zeiss instrument was not available at the time, however, so the Academy constructed a projector of its own design in the excellent shops that had been used to repair optical instruments for the Navy during World War II. Certain basic features of the Zeiss instrument were incorporated l
many improvements were made.

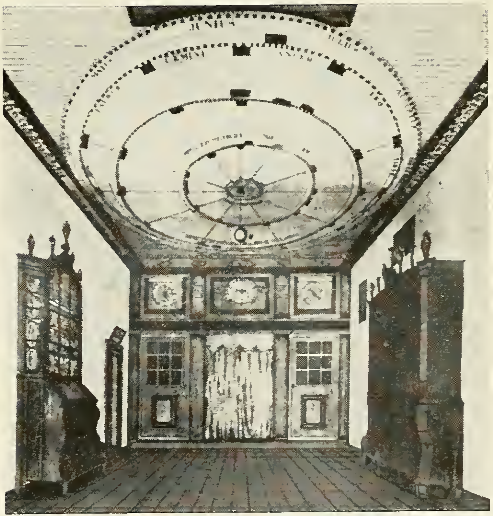
The San Francisco projector is quieter in operation th
earlier instruments. The hemispheres containing the st
plates have been brought closer to the center, giving
better distribution of weight and improving the instr
ment's appearance. The planet projectors, which are lig
in construction, have been put at the two ends of the instr
ment, instead of at the waist, as in the Zeiss design. T
moon is not just a round, white disk but an actual pho
graph of the moon projected on the dome. The stars the
selves give a greater illusion of reality.

The other "homemade" planetarium was recently u
veiled for public demonstration at the Charles Hayd
Planetarium of the Boston Museum of Science. Althou
the planet, sun, and moon devices are not yet complete
demonstrations using the stars have been given sin
October, 1958. The projector is being built by the broth
John and Frank Korkosz of Springfield, Massachuset
who built a smaller planetarium for the Springfield Museu
some years ago.

The Korkosz instrument, like the one in San Francis
is based partly on Zeiss principles, but has the star pr
jectors mounted near the center rather than at the en
Also, the machine has a "semisphere" and four "quart



s" for the stars of each hemisphere. Stars of the first
cond magnitude are projected from the semispheres,
those of the third, fourth, and fifth magnitude are
ted from the quarter-spheres. A thousand-watt bulb
l in each unit for the bright stars, five-hundred-watt
for the fainter stars, and still smaller bulbs for very
stars. Eighty-eight projection units cast images of
lual bright stars. The resulting sky contains no star
greater projected diameter than one-half inch.
planetariums built by the Spitz Laboratories, to be
Flint and at the Air Force Academy are designed
comparable to the Zeiss instrument. In appearance.
re similar, but there are several differences. As in the
stars are produced in spheres at the two extremes.
Spitz. however, the source of light is a unique, high-
ity arc lamp. Armand Spitz. who conceived the in-
nt, is said to have come upon the idea for his
ion system from watching light being reflected in all
ons from a Christmas tree ornament. A mirror re-
the light from the pinpoint source in all directions.
fied by a condenser system, the light then goes
gh small holes. Some of the brightest stars have sep-
projectors. so that the illusion of brightness derives
actual variation in *intensity*, not just from variation
of aperture. The entire projector assembly is sus-



Eisinga orrery, with wooden clockwork, was built about 1775 in Netherlands. Six planets move around pivotal "sun."

MR. CHAMBERLAIN, Chairman of THE AMERICAN MUSEUM-HAYDEN PLANETARIUM, recently returned from the Zeiss plant in West Germany, where he inspected the instrument that was installed in the Planetarium in January of 1960.

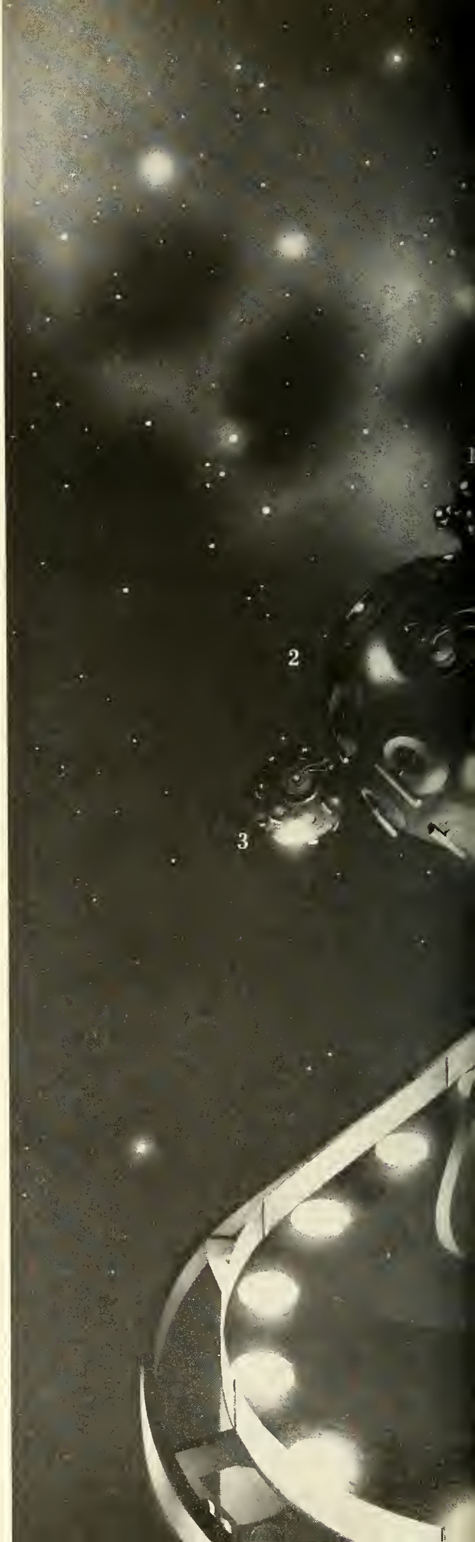
pended from cables secured to the ceiling, leaving the impression that the unsupported instrument is floating in space, with no structure between it and the floor.

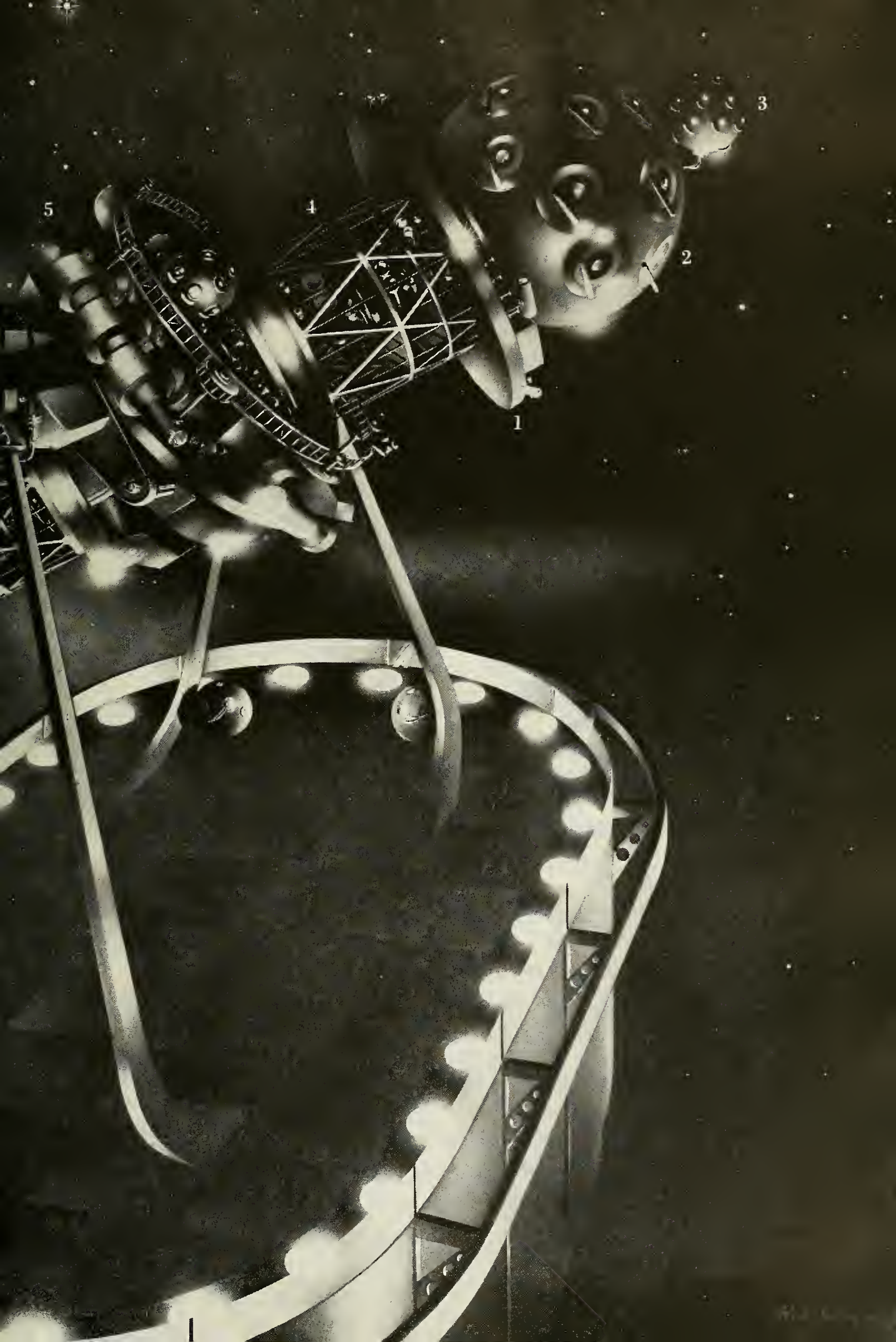
SINCE 1953, a number of scientists and mechanics have been working at the Zeiss factory in Oberkochen, West Germany, on a new planetarium series with numerous technical improvements and amplifications. Perhaps the most significant improvement involves the representation of star magnitudes. The problem of restricting the diameter of the projected stars to a certain limit, while retaining the natural relative brightness of the images, has been solved by using special projectors for the forty-two brightest stars. These special projectors, as well as three special projectors for the three variable stars and two special projectors for the Milky Way are all situated between the star balls and the planetary frameworks. The remaining nine thousand stars shown by the new Zeiss instrument are produced by a new photochemical method on fixed star plates. Improved, coated optics further enhance the quality of projection. Other changes include a redesigned moon projector and a greatly amplified range of motions to enable the lecturer to control the moving sky more fully. The first of these instruments in the U.S. was installed last month at The American Museum-Hayden Planetarium in New York.

The competing Zeiss factory in East Germany has also re-established a planetarium department since World War II, having produced a new model instrument for Stalingrad in 1954, and others since. There, too, attention has been directed to reducing the size of the projected images of the bright stars. Copper foils embedded between glass plates serve as transparencies for fixed-star projection, as in the earlier instruments. However, in the former foils, the sizes of the holes ranged from .023 to .075 mm. In the newer model, the holes range only from .023 to .045 mm. Another significant change is the provision of infinitely variable drives for diurnal and annual motions.

THE time may not be far distant when planetariums will be as numerous as museums. In this age of emphasis on science, such a trend is more than welcome; it is mandatory. For, in modern context, "planetarium" connotes a great deal more than a model of the solar system. It refers not only to the instrument and its great hemispherical dome: the word goes on to embrace exhibits concerning astronomical, navigational, and related subjects, and instruction in a field of interest that weighs ever more heavily on today's imagination—accomplishments along the new frontier of outer space. In the second half of the twentieth century, centers of information in this field are no longer the playthings of latter-day Earls of Orrery: instead, they are very nearly necessities for most modern communities.

NEW PLANETARIUM's parts are numbered in drawing, *right*. Ruffs at bases of two large spheres (1) project the forty-two brightest stars. The two spheres (2) project all other stars. Tiny spheres at each end (3) project constellation outlines, while pair of cages (4) house projectors for sun, moon, and planets. At center (5) are motors that move the instrument, gear housing, and the supplementary projectors.

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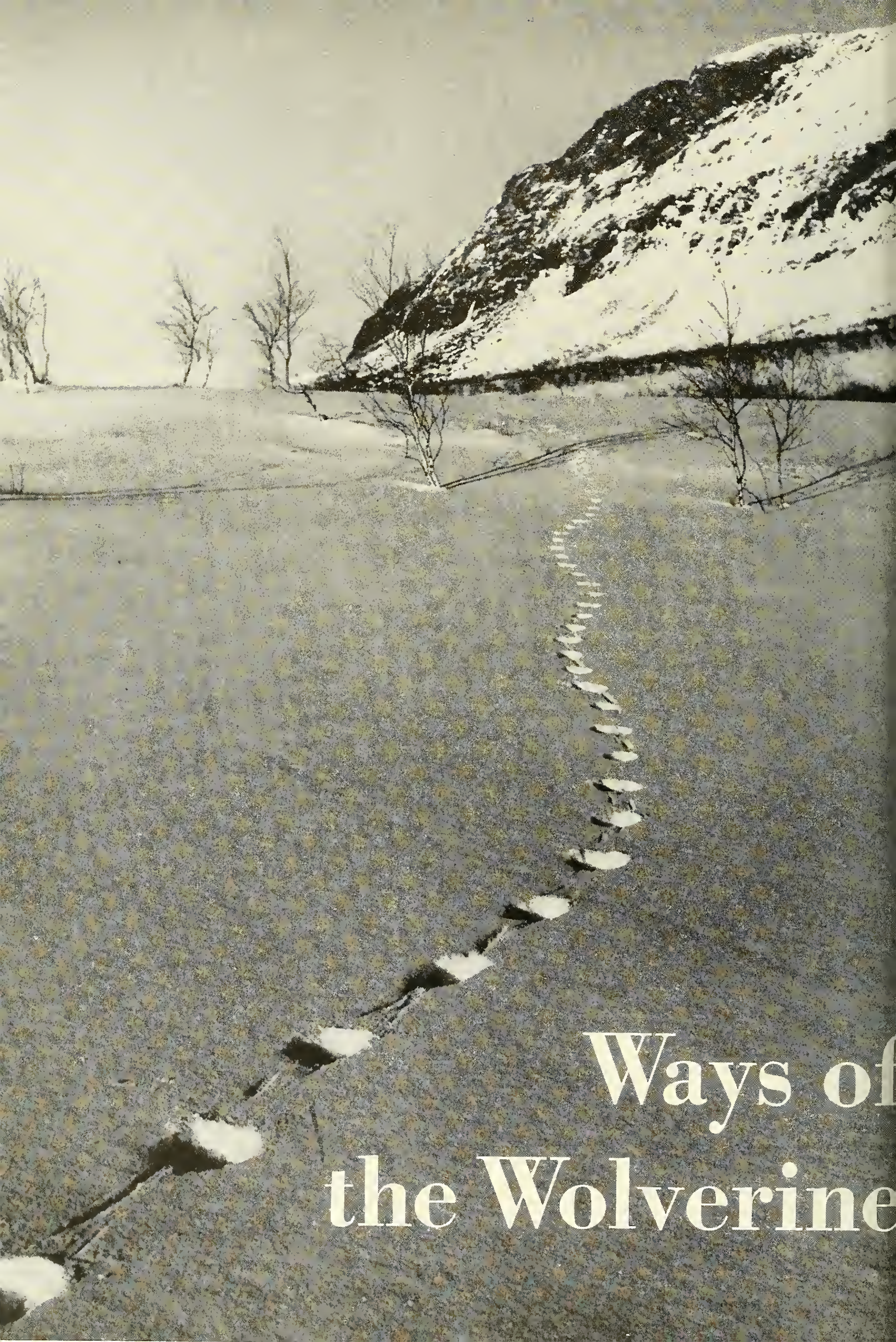
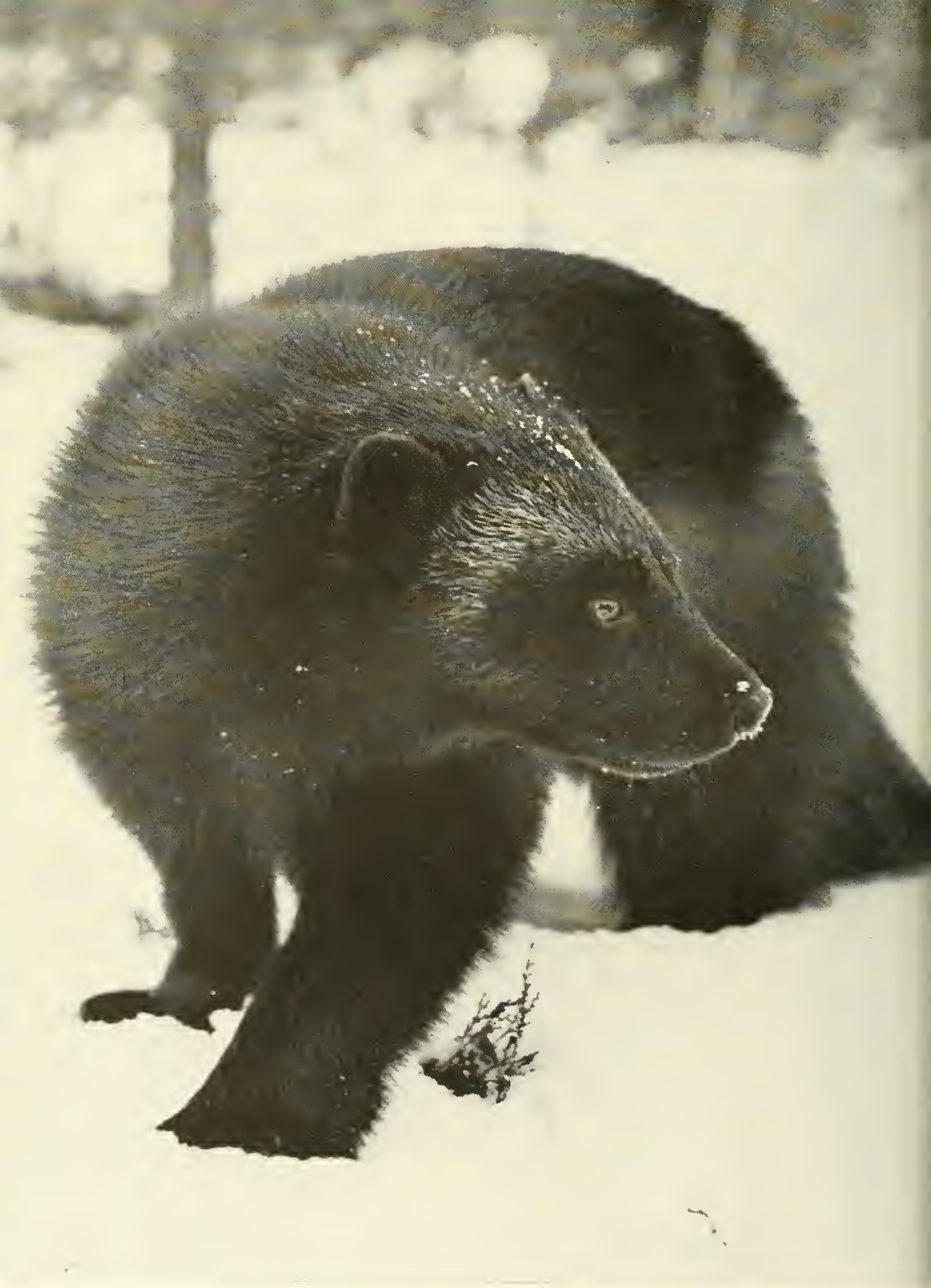


Ways of the Wolverine



Wolverine on the alert is seen in typical pose here, as it sniffs the air. More cautious than most animals, even in safe situations, creature will habitually seek high gr when awake, but when exhausted will go to sleep anyw

animal inhabits a vast area
hich it is peculiarly adapted

By Peter Krott

LARGE MAMMALS were as little known as the
verine, until recently. In fiction, this animal is
cast in a role best described as "the demon of the
In scientific treatises—and, incidentally, in all too
them—the data concerning wolverines are often
omplete and incorrect. Yet we should not be sur-
hat this is so: the wolverine lives in very small
s in some of the most solitary and inaccessible
on earth. It is restless, extremely cautious and
us of man. Therefore, even the most enthusiastic
ologist, roving the northern forests, will seldom
olverine, let alone be able to study one closely.

excellent study of the wolves of Mount McKinley
ance, the mammalogist, Adolph Murie, says that
r saw a wolverine, even though he frequently
d the animals' tracks. Murie found it no trouble,
, to see and study the *rest* of the fauna of Mount
y National Park. Until recently, then, one may
writers of fiction and zoologists alike depended
erine lore upon what they heard from others.
rica, their principal sources of information were
and trappers and, in Europe, the Laplanders. And
reliable these informants were! Indeed, there is
al that the people of the northern regions detest
is easy to imagine the tales they tell.

WOLVERINE AT PLAY momentarily pauses while rolling in the snow, a very frequent habit even when animal is traveling.

DURING almost twenty years of residence in Northern Europe, I have come in very close contact with this strange animal. As I grew more and more interested, I finally decided to remove to the land of the wolverines for a certain time, so that I might literally live *with* them and study their behavior. This seemed the only practical way to learn something of the habits of these shy animals.

In the forests of Sweden, where I undertook my major experiment, four wolverines—which I took from their

NE ON THE PROWL climbs on to fence about author's
otoriously mischievous, the wolverine will make apparently wanton havoc of everything within reach; but playful exploration is part of animal's way of learning.

Winter habitat of the wolverine is seen above—powdery snow of lakes and coniferous forests surrounding the Pole.

nest as cubs and bottle-fed at home—were invaluable animal assistants. My wolverine children were always able to move about freely. When they did not need the bottle any more, they began to roam far out into the land of the wolverines, which extended for many miles beyond my cabin door. But these hand-raised animals never lost their ties to me and my wife. They visited our cabin, allowed us to follow them on their secret paths, and finally also brought us in contact with the wolverines living wild in our area.

Wolverines are the largest of the mustelines—a subfamily that includes the mink, marten, weasel, and ferret—and they are closely related to the martens, with which they share some common characteristics. The Old World and New World wolverines have been considered in the past to be different species, but most students presently regard them as only subspecifically distinct, with *Gulo gulo gulo* in the Old World and *G. g. luscus* in the Western Hemisphere. My own opinion is that even subspecific separation is based on characters too trivial for this degree of recognition. The skull material which I have examined and compared does not reveal distinct differences between the two. Nor can they be divided on the basis of the size and the quality of their pelts. The fact seems to be, rather, that geographically, from Alaska in the west until one reaches Manchuria in the east, wolverines decrease in size continually but insignificantly and that, proportionately, the quality of their pelts decreases somewhat. But the differences are very small and one is amazed at the uniformity of the species in its vast area of distribution.

Dr. Krott spent several years in Scandinavia studying th wolverine, first in Finland and then in Sweden. His book *Demon of the North*, was published in the U.S. by Knopf

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Today, the wolverine is an animal of circumpolar tribution, primarily inhabiting the northern c ferous forest region. It cannot, however, be found ev where in this region and, even where found, it is sparsely represented. In contradistinction to most o northern beasts of prey, the wolverines' area of distr tion has hardly decreased in historical times. Man driven them only from some southern fringes of t habitat, such as some parts of the U. S., southeast Can Estonia, Latvia, Lithuania, northeast Poland, and s Russian provinces.

The length of the wolverine's body is little more three feet, and eight inches of this length consists of The height at the shoulder is about seventeen inches; weight can be upward of seventy-seven pounds, but average weight of adult males I have seen in Europ about fifty-five pounds. Females are a quarter to a t lighter and also smaller. The animal is built for en ance. Indeed, it is lumbosacrally overbuilt; the extr ties are acutely angled when the animal is in motion, soles of the feet are thick and the whole muscular sy is highly developed. The wolverine's locomotion on ground can be compared to the snapping of a spr The wolverine becomes sexually mature in its fourth but the sutures of the skull are grown together at e months and the teeth are also fully developed.

Like most mustelines, the wolverine has numerous very active glandular organs, of which we mention a pair of anal pouches that secrete a malodorous, yel ish-green fluid (in my opinion, however, of a far unpleasant odor than that of the skunk). The wolve is able, incidentally, to spray this fluid for a distance to nine feet. The yellowish spot on the animal's abdo further points to the existence of glands in front of genitals, something not often found in the animal k dom. Like the marten, the wolverine also has a spo the throat area: in the wolverine, however, this is m smaller. Frequently it is scattered in little dots, and so times the spot is missing altogether. The possible gla lar nature of this has not yet been investigated.

The fur of the wolverine, is, I believe, the most derful fur ever borne by an animal. Presumably du the specially wide angle of insertion of the stra bristles and of the long, only slightly curled (and n matted) woolen hair, the coat never hardens, eve freezing temperatures. The Eskimos prize the fur of wolverine for facial protection and pay the trappe good price for it.

It seems odd that a virtually omnivorous beast of of considerable size should be ecologically bound to northern coniferous forest region. Still, this is a fact, one for which in my opinion the wolf is respons The wolves apparently confine the species *Gulo* to swamp areas of the coniferous forest region. Populat of wolves are much smaller in these wooded local than in treeless ones. Furthermore, the wolf cannot r in large swamps during the snow-free season. Finally wolverine, when engaging a wolf in a powdery sno the wooded areas, proves superior—as I have had o sion to see. If the wolverine has to deal with sev he can always rescue himself by climbing a tree. e treeless mountains and tundra proper, on the and, the wolverine enjoys none of these advan- 'or that reason, they have seldom been found the past. But, interestingly enough, the wolverine eared in the realm recently: in some of the north- regions of Russia, for instance, and even in nd. where he had not been seen from time im- al. Evidently, now that civilization has brought ccess in his struggle against the "plague of the the wolverine has been able partly to occupy the g wolf's ecological niche.

rines are not nomadic animals. as many people ought. Each inhabits a definite—although very rritory. In Scandinavia. I found one male to half-million acres. These territories have a rather population structure. A male wolverine shares realm with two or three bitches, and does not other male to enter his territory. Yet the male associates with the bitches for only a few weeks he rutting season. Each bitch, in turn, inhabits subterritory within the male's larger preserve all lf. In such a subterritory, another bitch is not . It was very interesting for me to observe that al wolverines show mutual, strict respect for these l boundaries.

nimals recognize the territory peculiar to each individual by its feces, by the scent of the individual's spoor and. above all, by the scent marks that the animals post regularly by rubbing their ventral sides at certain points. Besides all this, the wolverines mark their territories—as do dogs—by the discharge of urine.

Wolverines do not wander aimlessly about their territories, but stick to certain trails. These, however. are not narrow paths but, rather. strips of terrain about half a mile in width. These trails are not like those of other northern game: for the most part, they run in wide, serpentine lines with frequent changes of direction. The vast extent of wolverine territories makes it impossible to say when, exactly, the wolverine will appear at a certain point on its trail. When the animal scents carrion or suspects danger, it leaves the trail at once.

The diet of the wolverine is markedly different from that of other carnivores. Above all, it is a carrion-eater, preferring this to any other food. But the wolverine feeds on other things, too. In the early summer. for example, the eggs of ground-breeding birds are a favorite meal. It searches for clutches mainly on the banks of rivers and lakes, and in swamps, and does not despise the eggs of even the smallest warblers. Later in the summer, the larvae of wasps constitute the daily menu. despite the stings of the furious insects. Be the nests terrestrial or arboreal, for days on end our animal does nothing

HABITAT is shown here. Type of country remains the ing both seasons. but in winter the animal can cover a wider area safely, hence is more predatory. During summer, its range is narrowed and its diet also includes vegetation.

Trail of footprints is broken when wolverine takes a roll in the snow. The animal's tracks are comparable to those of the bear, although shorter and much narrower. Its habit gait is a gallop and, when hurried, a leap; trotting is ra

Climbing a tree, wolverines try to reach food cached in branches. Normally, food is hidden in holes in the ground.

earch for and greedily plunder the wasps. Then
s replace wasp larvae as a favorite food and, for
. the wolverine, like the bear, feeds only on the
flora of the North, unconcerned with the kind of
s it is eating.

HE summer, wolverines do not usually prey on liv-
g animals, for their way of hunting makes that
t impossible. Unlike the cats, they do not lie in
or or stalk their victims. Unlike the wolf they do
ase their prey swift-footedly to death. Rather, the
rine pursues slowly but with enormous endurance.
snow-free season, our animal has, of course, no
e to do this: the other northern game is far superior
n swiftness. Further, wolverines cannot move with
. They make, in fact, no effort at all to suppress
compared to them, bears move almost inaudibly.
e summer, therefore, the intended victims of the
rine are almost always warned of an approach in
o escape.
winter, this situation changes fundamentally. The
of course, allows the wolverine to make a more
approach. But, more importantly, in the snow our
l is far swifter than its victims. With widespread
the wolverine moves effortlessly even in the softest
r, excelling all other northern mammals. In the
, then, it becomes a terrible enemy, preying even
e moose and the lynx. In Northern Europe at this
of year, wolverines are the scourge of the Lap-
s' domesticated reindeer while in summer, when
indeer calves are born, they are less harmful.
appetite of the wolverine is relatively modest. Once
ur animal is not even interested in an arctic hare
ay arise out of the snow only a few yards away.
ermore, it is not generally known that wolverines
ish large "food depots." Digging deep holes either
swamp, in soft ground, or in the snow, they store
mainder of the prey they have killed or the carrion
ave found. These caches are neatly covered with
or with snow, but the animal is able to find them again with unmistakable certainty. If the nature of the ground is not suitable for building such caches, the wolverine takes its food up into a tree—in most cases a pine tree—and hides it very skillfully at the angle of branch and trunk. The food is pressed so tightly into these angles that not even severe storms dislodge it.

The rutting season of the wolverine comes between April and August. Like many other members of the weasel family, wolverines have a prolonged gestation period. The bitch brings forth an average of two to three young some time between February and April. The beginning of the rutting season and, of course, the birth season, seems to be related to the latitude and altitude of the wolverines' territory: high latitude and a far northern latitude cause a delay. A bitch is in heat only every two to three years; the male therefore need associate only with one of the bitches in his territory for a short time each year.

The cubs, which weigh only some three and a half ounces at birth, remain blind for about four weeks. They are suckled by their mother up to ten weeks. Their first solid food are pieces of carrion from the caches set up

**MING is common means of sport and travel in the lakes
ot wolverine country, and may also have hygienic use.**

Young wolverine sucks the contents of bird's egg. Eggs are found in ground-breeding species' nests by rivers or swamps.

by the mother. She carries these gobbets—well mixed w
saliva — to the den and regurgitates them in or
to give them to the cubs. The young remain in their n
for six to eight weeks, and then leave it under the wat
ful eyes of their mother and move gradually farther a
farther away with her. Already, in their first autur
they will follow her on long hikes. As early as th
fifth month, they are well acquainted with the ways
marking a territory and are masters in the hiding of fo
in caches and trees. However, the young wolverines
able to prey independently on larger living animals o
in the second winter of their life.

The young, who have no contact with their father, s
with the mother up to the age of two years. For t
length of time, they are also tolerated by the male wit
the confines of his territory. Later, the young bitches
driven away by their mother and young males by th
father, unless there is a vacancy in the territory.

NLIKE many other animals. the wolverines do not
know inactive periods. Most of the time, they adhere
a peculiar rhythm of sleeping and waking: three to
r hours are devoted to sleep. they are active for the
ne length of time, and then the cycle repeats. How-
r, they will sleep through days of heavy snowstorms
unusually heavy rain. On the other hand, dry weather
h a stiff wind, a full moon, or a bright aurora will
p a wolverine specially active and it will not rest for
ull twenty-four hours. Strong hunger also keeps a
verine awake.

ur animal spends most of its life on soft ground, in
snow or in swamps. Its normal gait is the gallop.
he snow is very powdery or the wolverine is in a
at hurry, it leaps. Unlike the dogs, wolverines seldom
. Their tracks show mostly the characteristic pair-step
the martens: they take *maximal* advantage of the
und. In deep snow a wolverine digs itself forward
like a lemming and, particularly when playing, rolls along with repeated somersaults. Our animal likes to climb and can climb head-down but, unlike arboreal martens, never jumps from one tree to another. However, I have observed a wolverine hanging by hind legs only from a strong branch nine to twelve feet above the ground and swinging freely!

Wolverine endurance in locomotion is incredible: they are able, when pursued, to cover over forty miles without rest. I once checked the distance covered by an eight-month-old male in one night. It was twenty-one miles!

It seems to me that the wolverines' sensory organs are not more highly developed than those of other mustelines, even though some advantage might be assumed for an animal that holds its own so successfully. The wolverine's senses of smell and hearing, while excellent, seem inferior to those of the wolf. On the other hand, wolverines take precautions more often than other animals. Even in what appear to be safe situations, they move to elevated terrain features, climb rocks and treetops or cock themselves on hind legs like a hare. They will even on occasion rise on their hind feet like a bear.

The wolverine plays more than other beasts of prey, almost more than the otter, which is well known as an animal extremely fond of play. The wolverine may play by itself, with an object, or with a partner; he plays

Wolverine cubs, *above*, play in underbrush. Born between February and April, cubs are two-thirds grown by late fall.

Adult wolverine at the left shows typical yellowish stripe extending from shoulder to tail and highly-prized long fur.

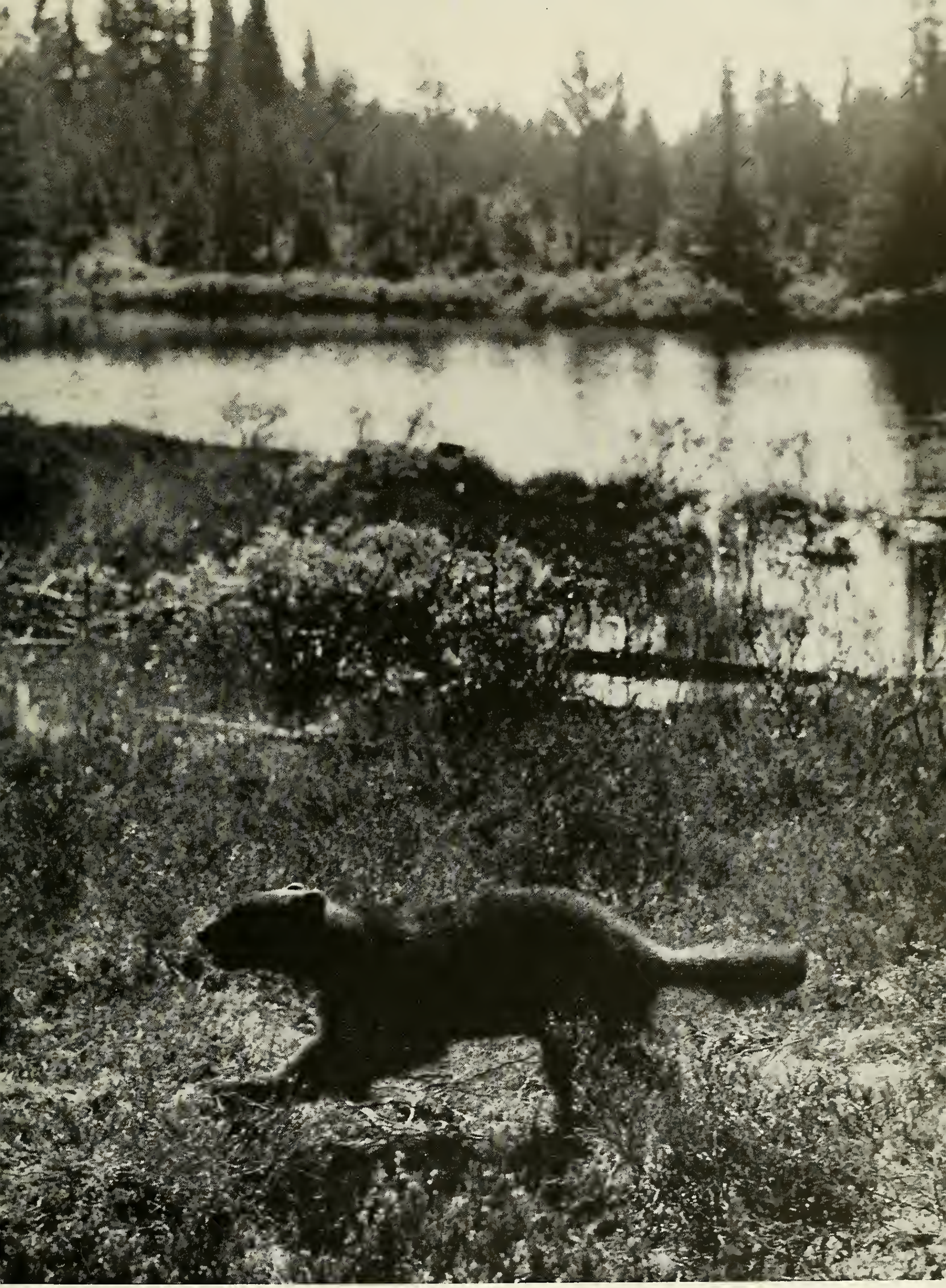
Ready to leap, a wolverine stands tensely poised. Easily covering five feet in high jumps, creature is less skillful as broad jumper. Despite its ability to climb, and unlike th arboreal martens, wolverine never jumps from tree to tree

both as a cub and as an adult animal. The consequences of the wolverine's fondness of play are all too well known to northern trappers. They break into cabins, carry away traps, snowshoes, and skis, tear covers and tents, and make general havoc. But the great activity of the wolverine expresses itself not only in playing, but also in the animal's *ability to learn*, which is considerable. By ability to learn, I mean the individual animal's capacity to change behavior in certain situations, without these changes of behavior being caused by nervous processes accompanying growth and maturation. Our animal behaves very plastically; in many sensory phases, the wolverine is able to learn something that is quite new to its innate modes of behavior.

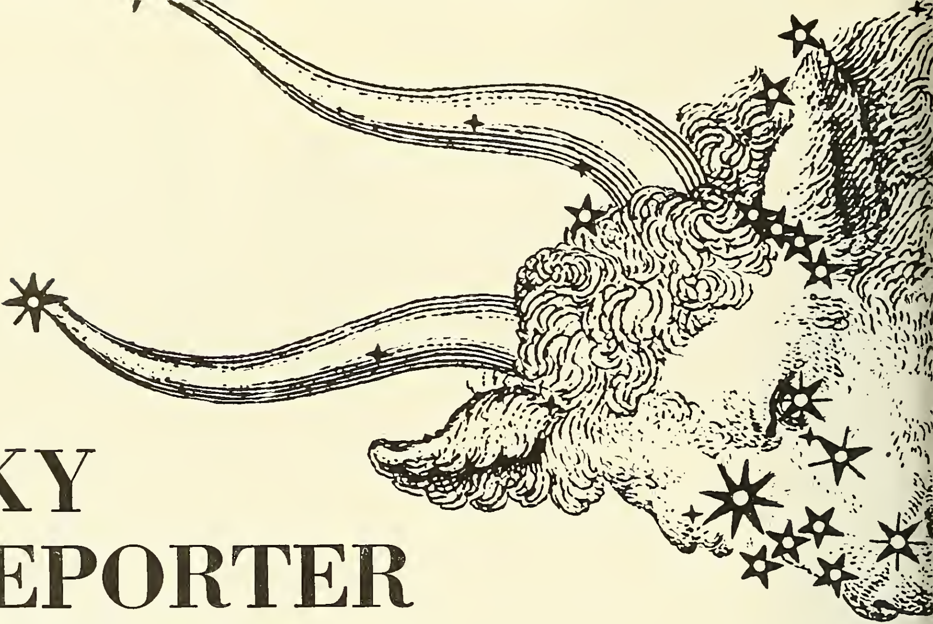
This love of play and ability to learn are, I believe, the basis of the wolverines' extraordinary ability to evade dangers. In that respect, they are far superior to any other northern mammal, including the wolf. They soon learn what is and what is not dangerous. Of course, many elements play a role in helping the wolverines to evade dangers that other inhabitants of their territory cannot escape: their unusually great endurance, even in deep snow; their habit of describing wide, serpentine lines that frequently change in direction; their strength, extraordinary for their size; their formidable dentition; and, above all, their habit of fleeing whenever something appears to be strange. I have often seen a bitch forsake her young unhesitatingly—and, in most cases, in good time—when a hunter came close to the nest. On the other hand, a cornered wolverine is the worst enemy one can imagine

After all we have seen here, we should not be surprise that it is extraordinarily difficult to hunt the wolverine A diminution of their numbers is possible only if on locates their nests, kills the young, or takes them aliv to the zoo. But even that sounds simpler than it actuall is, for the natural habitat of the wolverines is vast an their nests sparsely scattered and hard to find. One seldom succeeds in catching a wolverine in a trap. Eve when so caught, it bites off the trapped limb and escape —as a cripple. In addition, wolverines show considerabl immunity to poison. They can even take strong doses o strychnine without dying, as I had an opportunity t observe in Finland. Indeed, the bad name these animal enjoy rests not so much on the actual damage they infli upon man, but rather on the fact that they are so difficul to catch or to kill; for we detest most what we canno subdue. All the superstition of the North regarding th wolverine can be attributed to this apparent invincibility

Wolverines are, of course, also capable of quit different behavior. With the same perfection wit which they learn to avoid dangers and evade man, wolverines brought up with the bottle learn how to live wit man. My wife and I raised thirty young wolverines altogether and we concluded that no wild animal brought u by man becomes more faithful to his nurse and remain so even as an adult. At first, this may sound strange, bu it is not. It is only striking—like so much in nature which is always full of wonders.



-COUNTRY RUN is caught by camera. Wolverine moves fixed trails, but these are not narrow paths. Rather, they are strips of terrain up to half a mile wide, usually winding and seldom coinciding with routes of other animals.



SKY REPORTER

By Simone Daro Gossner

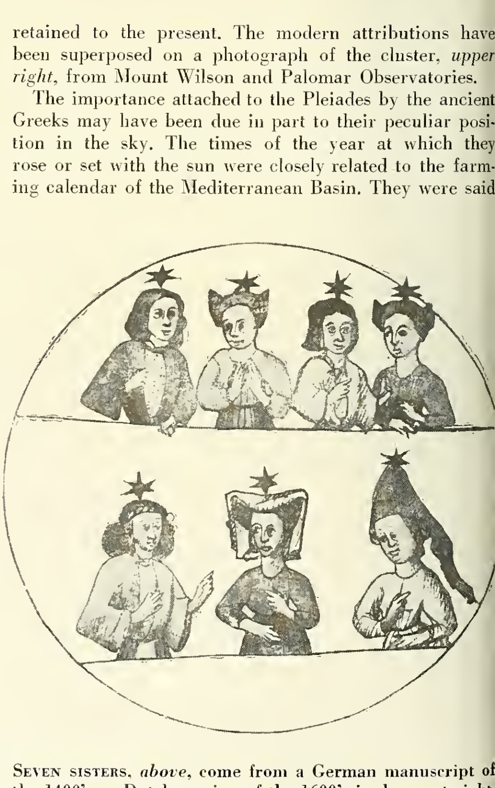
Although the Pleiades are now included in the constellation of Taurus, they were regarded as a separate asterism by the early Greeks. They are one of the original constellations described by Aratus (third century B.C.) in his poem *Phainomena.* According to the prevailing myth, the Pleiades were daughters of Atlas and Pleione. Aratus lists their names as Alcyone, Merope, Celaeno, Electra, Sterope (or Asterope), Taygete, and Maia. In so doing, he was possibly quoting from a history of Atlas and his descendants composed in the fifth century B.C. by Hellanikos of Mytilene. Aratus adds that, although there were seven sisters, it was possible to see only six of them in the night sky.

This reference to a lost Pleiad is so general in the legends of ancient peoples that it must stem without a doubt from a genuine astronomical "disappearance" in the remote past. Unfortunately, the ancients left no clue concerning the correspondence of the seven names with individual stars in the cluster. They were themselves at a loss to say which sister—let alone which star—disappeared. As recalled by Hyginus, one legend claims that Merope's light was dimmed because she was the only one who married a mortal; he also tells of Electra's sorrow at the fall of Troy (founded by her son Dardanus) and of her withdrawal from the mundane activities of her sisters.

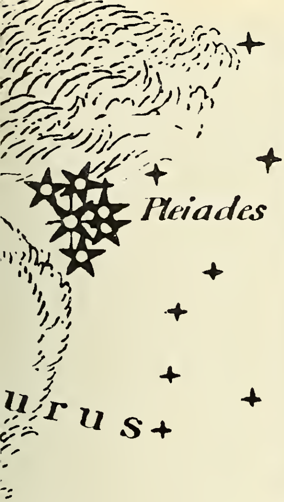
Medieval and Renaissance editions of Aratus' *Phainomena* have yielded some remarkable illustrations, in which the artists have shown, as a rule, much greater concern for aesthetic effect than for the accurate depiction of the asterism. The charmingly cross-eyed Pleiades shown at the right grace a fifteenth-century German manuscript. Their more classical counterpart was engraved by the Dutch artist Jacques de Gheyn for the Grotius edition published in Leiden in 1600.

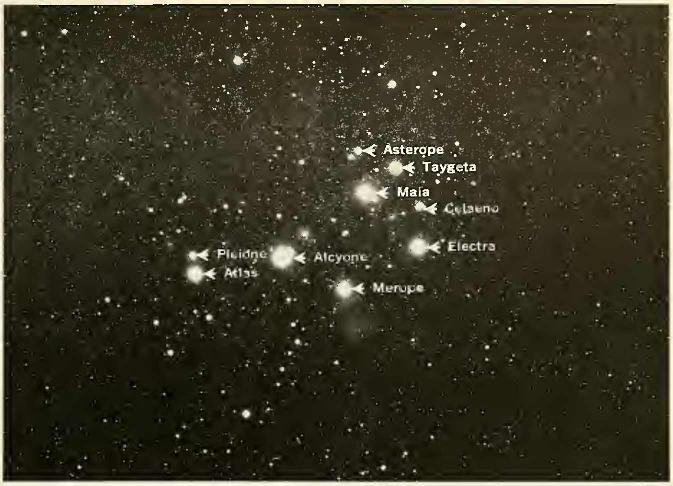
The names of the sisters and their parents have been retained to the present. The modern attributions have been superposed on a photograph of the cluster, *upper right,* from Mount Wilson and Palomar Observatories.

The importance attached to the Pleiades by the ancient Greeks may have been due in part to their peculiar position in the sky. The times of the year at which they rose or set with the sun were closely related to the farming calendar of the Mediterranean Basin. They were said



Seven sisters, *above,* **come from a German manuscript of the 1400's: a Dutch version of the 1600's is shown at right.**





Pleiades' position, in constellation of Taurus, is seen at left. The nine modern attributions are surprinted, *above.*

erald the sailing season, a fact which has led some ıologists to believe that their name had been derived ı the Greek verb *plein*, to sail (more likely, however, riginated from *pleion*, the Greek word for "more").

other parts of the world, the names by which the luster was known were as varied and colorful as the ıres from which they sprang. In India, it was the e of the fire god: the Chinese saw in it the seven rs of industry; the Hottentots called it a company of s who had shut out their husbands; the Abipone ans of Paraguay revered it as their grandfather. Not to be outdone in variety, European folklore yields a sieve in Finland, a group of old wives in Poland, a setting hen in Russia, and a chick incubator *(poussinière)* in France.

The Pleiades are no less interesting from a purely astronomical standpoint. The visual telescopes of the eighteenth century had already revealed the existence of a patch of nebulosity around Merope. After the introduction of celestial photography in 1851, it was discovered that not only Merope, but the whole surrounding field was embedded in nebular material. This is a mixture of gas and dust, which is dimly illuminated by the light of the stars that it surrounds.

Although a person with average vision may see only six stars in the cluster, one endowed with an unusually keen eye might count from eleven to fourteen. In fact, there are about twenty-five stars just beyond the range of human vision, and the telescope reveals several hundred more within a radius of less than a degree from Alcyone. All stars within the cluster share the same motion in space and undoubtedly have a common origin. It has been estimated that the cluster lies at a distance of approximately 400 light-years. Thus, the light we now see left the Pleiades in the times of Elizabethan England.

A MOST remarkable feature of this region has been detected by means of radio telescopes during the last three years. Radio telescopes observe radiation at wave lengths that are outside of the optical range. They can thus reveal the presence of celestial objects that are too cool to be luminous. By observing the 21-centimeter radiation of neutral hydrogen, it was found that there are a number of isolated sources of such radiation within the limits of the Pleiades cluster. The mass of each source may be estimated roughly from the intensity of the signal: the values obtained for these masses were in remarkable agreement with the mass of a star in formation. as predicted from theory. Thus, it is reasonable to assume that stars are still being born among the Pleiades. The French *poussinière* may not be so far fetched after all.

THE SKY IN FEBRUARY

From the Almanac:

Moon at First Quarter: February 4, 9:27 A.M., EST.
Full Moon: February 12, 12:24 P.M., EST.
Moon at Last Quarter: February 19, 6:48 P.M., EST.
New Moon: February 26, 1:24 P.M., EST.

For the visual observer:

With the exception of Mercury, all the planets will appear in the morning sky in February.

Mercury will be at its greatest eastern elongation on February 23. It will be too close to the sun for observation during the early part of February. Although it will become slightly more favorable as it nears elongation, it will appear very low over the western horizon and will remain difficult to see. It will set approximately an hour and a quarter after the sun from February 15 to 29.

Venus (magnitude —3.4) will be a brilliant morning star. It will rise two hours before the sun on February 1, an hour and a half before the sun on February 15, and an hour and a quarter before sunrise on February 29. On February 7, it will form a close pair with Saturn, the two planets being only two-tenths of a degree from each other on that date. On February 24, Venus will pass about four degrees south of the waning moon.

Mars (magnitude +1.5) will rise approximately one and three-quarter hours before sunrise during the whole month of February. By sunrise each day, it will still be low over the southeastern horizon.

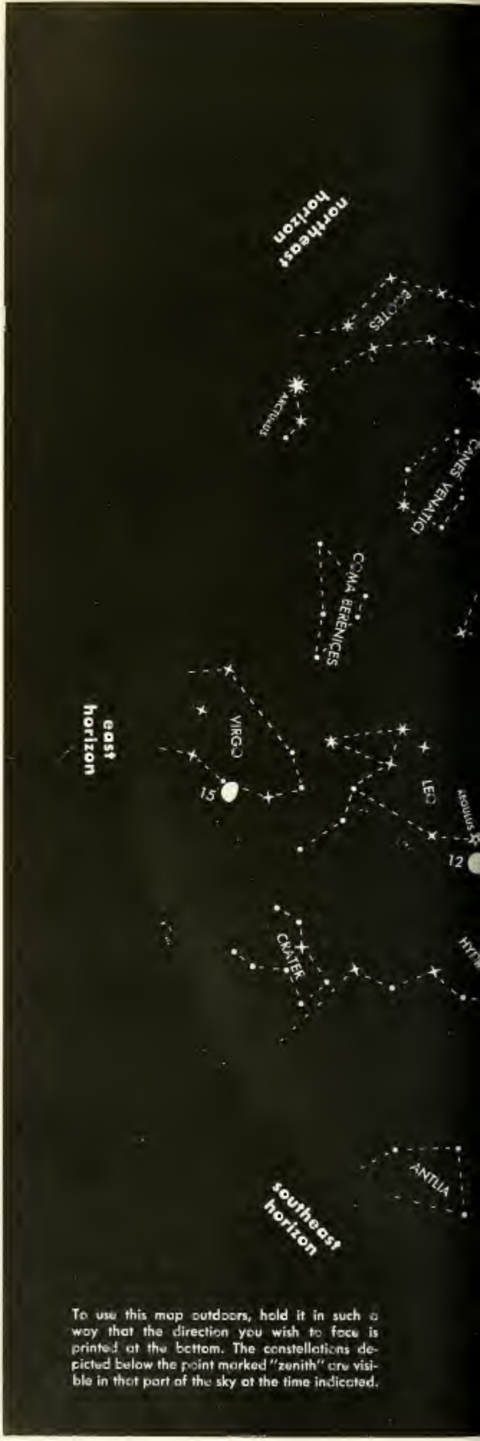
Jupiter (magnitude —1.5) will be found east of Antares, in the constellation of Sagittarius. It will rise three hours before the sun on February 1, three and a half hours before sunrise on February 15, and four hours before sunrise on February 29. By the end of the month, it will be low in the southern sky by sunrise.

Saturn (magnitude +0.8) will also be found in Sagittarius, trailing Jupiter by somewhat over an hour. Accordingly, it will rise approximately one and three-quarter hours before the sun on February 1. two and a half hours before on February 15, and three hours before on February 29. It will be low over the southeastern horizon at sunrise.

Constellation study:

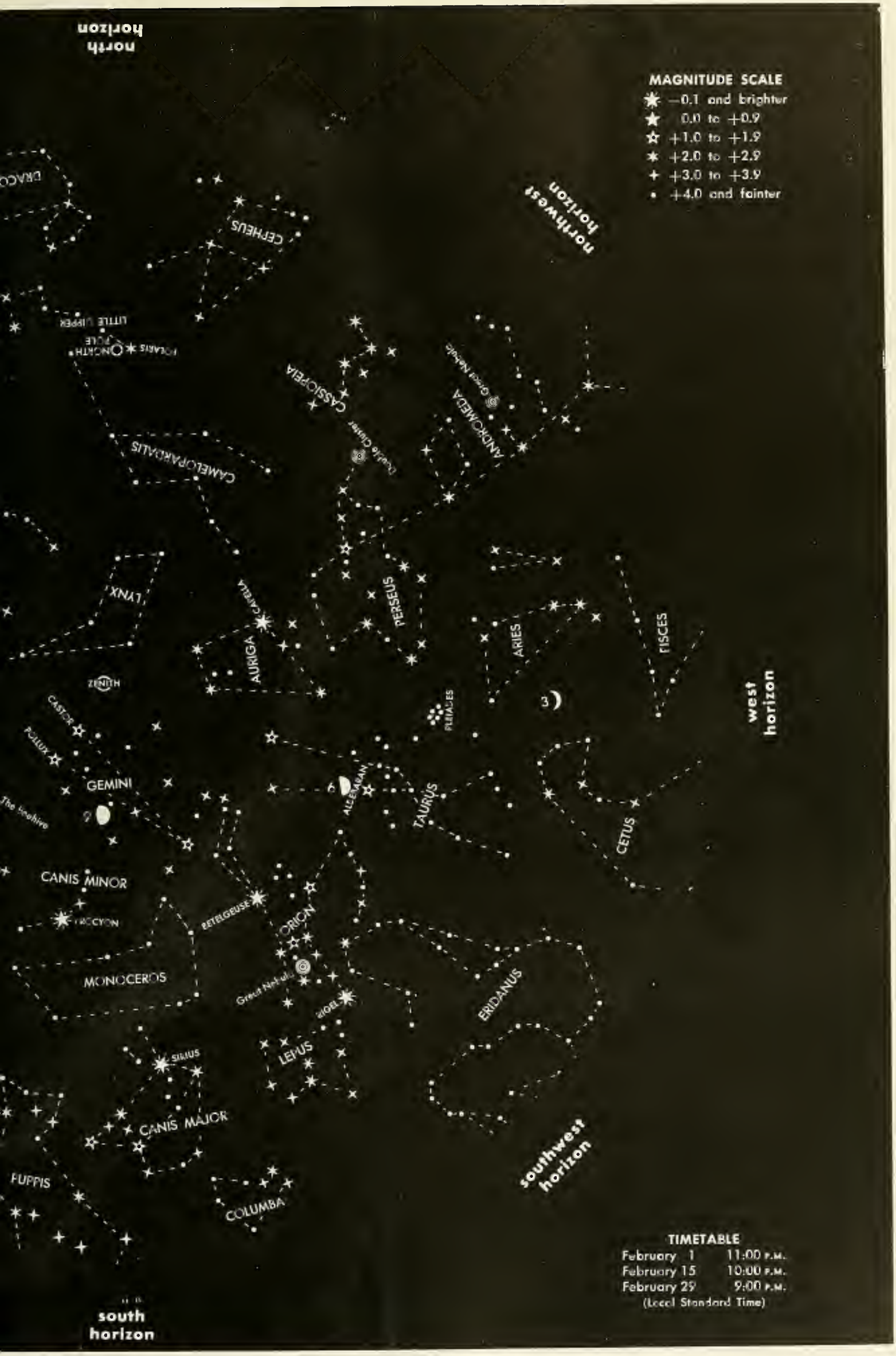
Early evenings in February afford the observer his last look at the winter skies. Many of the brightest stars visible in the Northern Hemisphere are conveniently grouped above the southern horizon, providing the beginning student with a guide to their respective constellations.

Facing south, at about 10 P.M., one should first locate Orion, slightly to one's right. This large, lopsided quadrangle with three stars (Orion's Belt) strung across its middle, is a striking and easily recognized group. The star map will help identify Betelgeuse and Rigel, composing the upper left and lower right corners, respectively, of the quadrangle. The bright red star to the right of Betelgeuse is Aldebaran, in Taurus, with the Pleiades a little farther beyond. On the other side, the first bright star to the left of Rigel is Sirius, the Great Dog Star. The Little Dog, Procyon, forms an equilateral triangle with Sirius and Betelgeuse. A straight line from Rigel to Betelgeuse leads directly to the constellation of Gemini with its twin stars, Castor and Pollux, close to the zenith.



To use this map outdoors, hold it in such a way that the direction you wish to face is printed at the bottom. The constellations depicted below the point marked "zenith" are visible in that part of the sky at the time indicated.

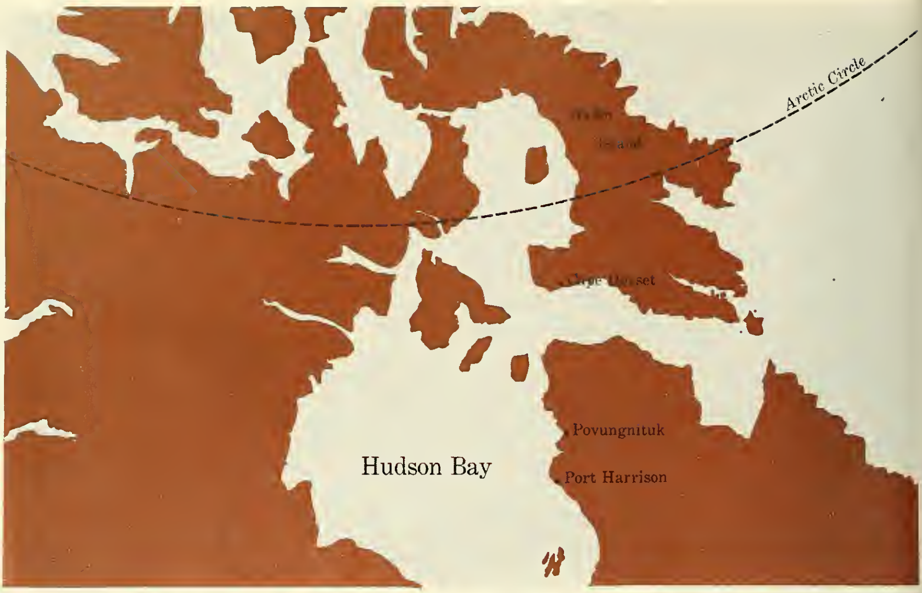
The former Astronomy Editor for NATURE Magazine, MRS. GOSSNER, continues in that role for NATURAL HISTORY.


north horizon
MAGNITUDE SCALE
−0.1 and brighter
0.0 to +0.9
+1.0 to +1.9
+2.0 to +2.9
+3.0 to +3.9
+4.0 and fainter
northwest horizon
DRACO
CEPHEUS
LITTLE DIPPER
NORTH POLE
POLARIS
CASSIOPEIA
Great Nebula
ANDROMEDA
Double Cluster
CAMELOPARDALIS
LYNX
CAPELLA
AURIGA
PERSEUS
ARIES
PISCES
west horizon
ZENITH
CASTOR
POLLUX
GEMINI
The Beehive
PLEIADES
3
6
ALDEBARAN
TAURUS
CETUS
9
CANIS MINOR
PROCYON
BETELGEUSE
ORION
MONOCEROS
Great Nebula
RIGEL
ERIDANUS
LEPUS
SIRIUS
CANIS MAJOR
PUPPIS
COLUMBA
southwest horizon
south horizon

TIMETABLE

February 1	11:00 P.M.
February 15	10:00 P.M.
February 29	9:00 P.M.

(Local Standard Time)



Majority of Eskimo sculpture shown on these pages comes from east coast of Hudson Bay and Baffin Island.

ART OF THE ESKIMO

The sculpture of these people captures the spirit of the cha

By EDWARD M. WEYER

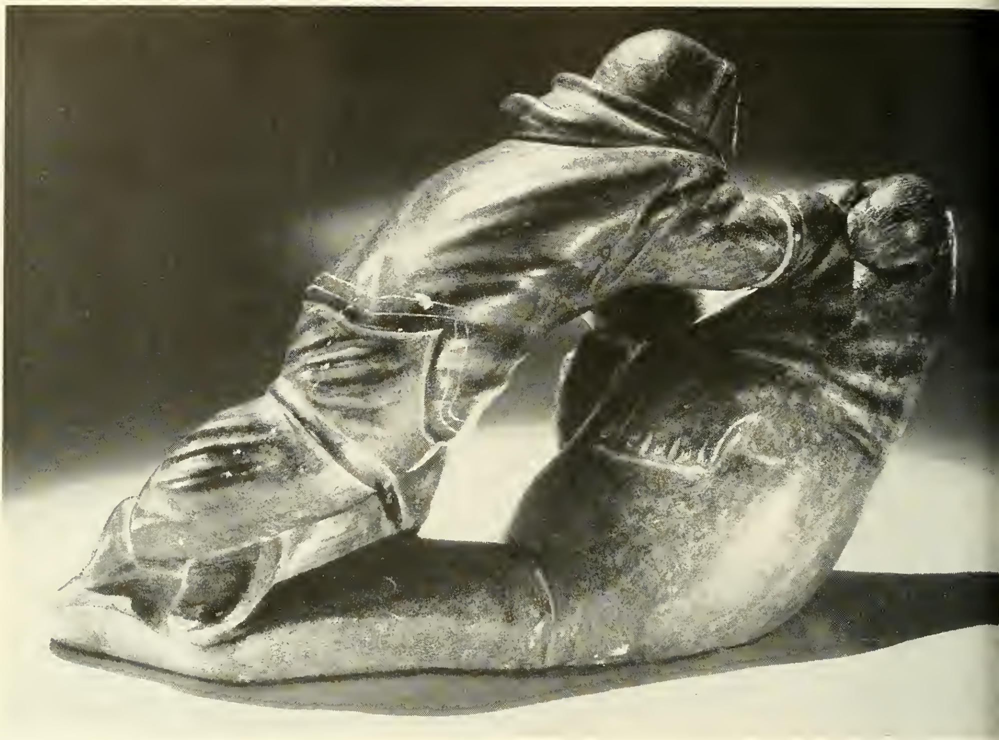
Photographs by LEE BOLTIN

BOUND INSEPARABLY to a hunting life from early times, the Eskimos have produced an art that, like their philosophy, their poetry, and their daily conversation, is redolent of the spirit of the chase. Various phases of this art may be distinguished. Archeological specimens, for example, prove that the artistic flair of the Eskimos is ancient. Elaborate, curvilinear designs ornament the hunting weapons of the Old Bering Sea culture of about 2,500 years ago. Stylized figurines and carved animal forms are found in some of the later stages. The acquisition, at least a thousand years ago, of iron from Siberian tribes influenced the engraving of bone in the Punuk period, producing abundant "compass-drawn" circle-and-dot designs. The eastern Eskimos, in turn, received iron from the Norse, probably as early as the twelfth century A.D. But is was apparently not until early Russian traders encouraged the production of hunting scenes in walrus ivory that such subjects became a characteristic form of Eskimo art. Realistic figures in stone, like the ones shown on these pages, came even more recently. They depend for their execution on a varied supply of scrap metal—the castoff files, saws, and other implements of Western man.

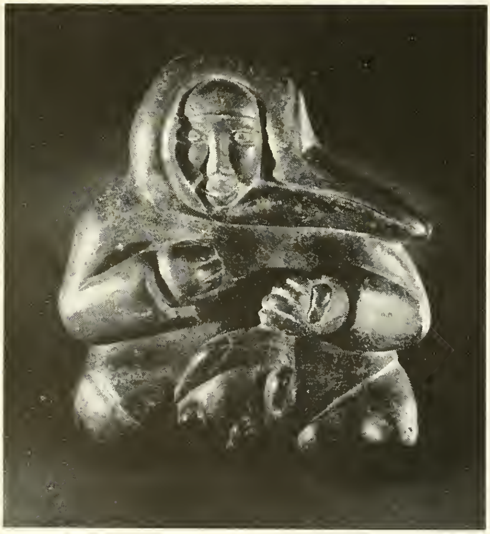
A single man has played a prominent role in stimulating the Eskimos to produce this type of art. Returning from the east coast of Hudson Bay in 1948 with a representative collection, James Houston was encouraged by the Canadian Handicrafts Guild, a non-profit organization, to procure enough pieces to test their appeal on the general public. The next year, Houston brought out about a thousand objects, and a one-week fair was arranged in Montreal. All of the pieces were sold in the first three days.

Eskimos all the way from Hudson Bay to Ellesmere Island in the far north were encouraged to carve, and a majority, including youngsters in their teens, responded. By 1954, sixteen traveling exhibits had been organized and about 25,000 pieces sold. The income received by the Eskimos has provided an important cushion against the economic difficulties they have suffered in their adjustment to contact with civilization. And they enjoy the work.

Man with ivory fish seems to be thanking heavens for bounty. Lucassie of Port Harrison carved the piece.



Hunter, coping with slain walrus, gives a sense of Eskimo concern for food. By Peter Angutikok of Povungnituk.

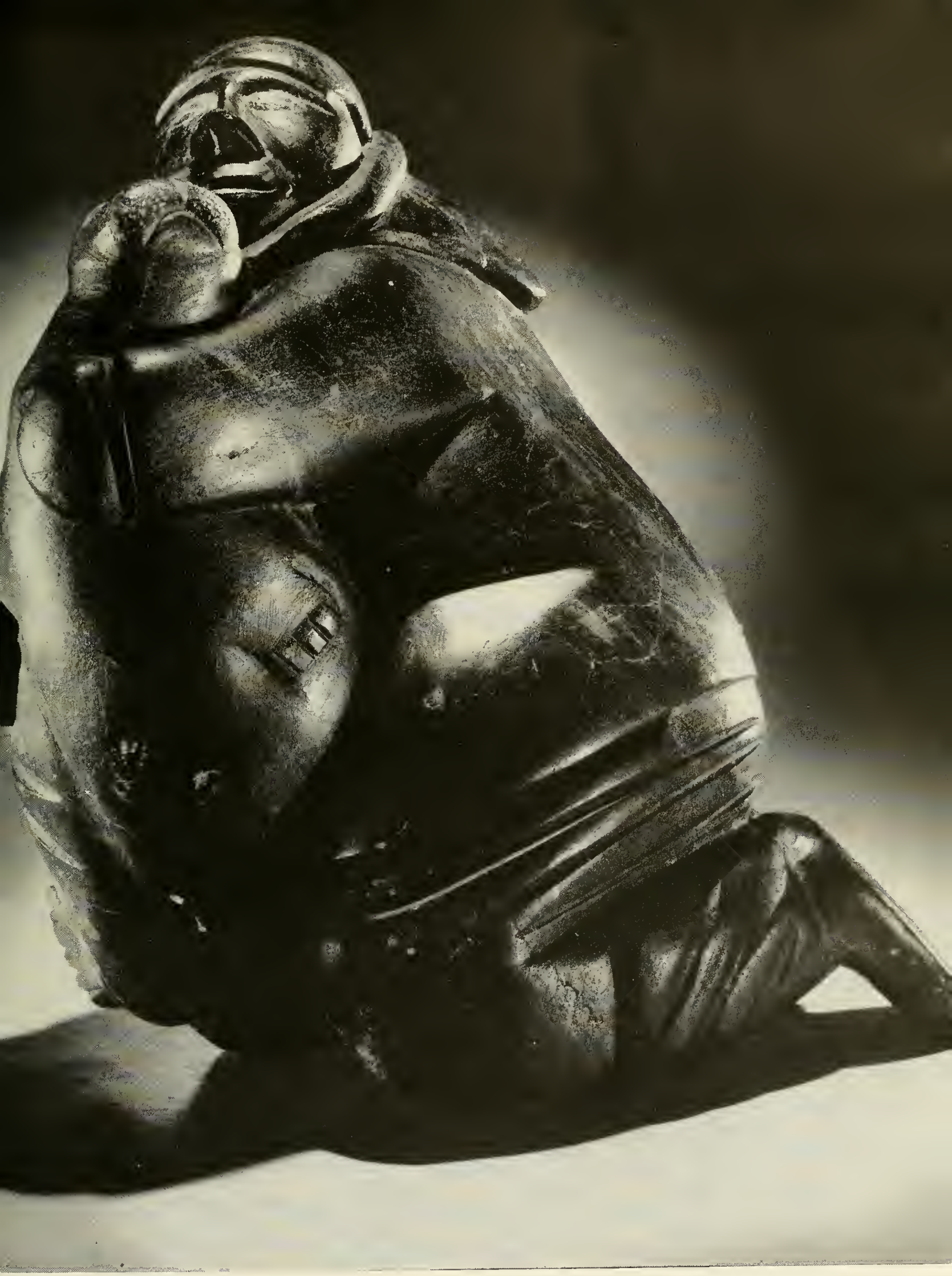


Kneeling woman, in wind-blown parka, holds a captured ptarmigan. Work of Tamusseapik of Povungnituk.

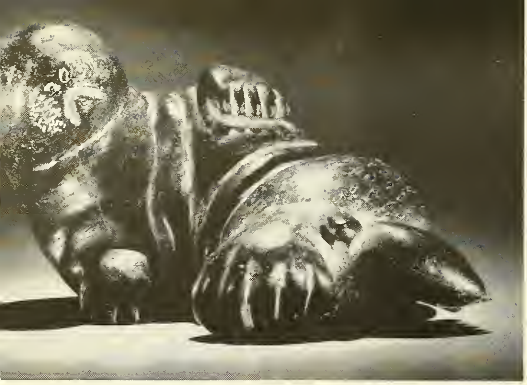
Every effort is made to keep the artistic tradition of these artists free from alien influences and mass-production pressures. But complete success in this can hardly continue for very long. Fortunately, the native artist shows disinclination to make two objects exactly alike or to copy his neighbor's work. But there is a temptation to grind out "souvenir" pieces. In one locality, Povungnituk (see map, p. 34), the better artists have formed a group to preserve artistic standards. They hope to sculpt a series of salient scenes from Eskimo mythology.

The Eskimo artist is apt to display extreme modesty about his ability, saying that a given piece is hopelessly bad or that no one should think of giving anything for it. But payment is always made—even for the lesser creations—and no one else need ever know what evaluation was written on the chit the sculptor received. The Eskimo artist may seem careless when he stuffs the slip of paper under his furs, but it is said that not one chit has ever been lost.

Dr. Weyer, for many years Editor of Natural History, is a well-known Eskimo authority. Mr. Boltin is an expert photographer of primitive art.



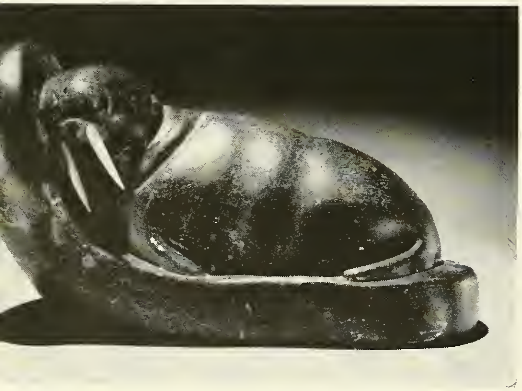
ling with a seal, this hunter has a firm grip on his quarry.
is by Levi Kumaluk, a leading Povungnituk artist.



Baby walrus was captured by Eskimo sculptor in a moment of playfulness or surprise on the edge of the ice.

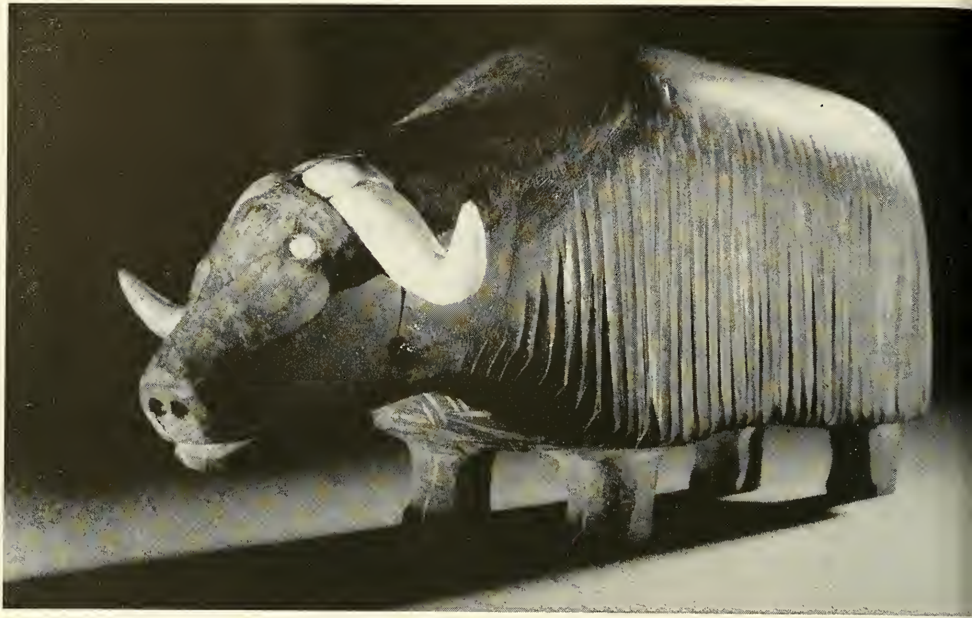
Most of these stone carvings are of a size easy to handle. In aboriginal times, heavy stone was a handicap during seasonal migrations, and the art of the Eskimos was probably inspired largely by religious motives. Small pieces were worn under the clothing as amulets, and miniature replicas of useful objects were placed at the grave of a departed relative to serve his spirit in the future life. Small figurines may have been used as dolls and toys.

But these modern carvings are intended to be handled and enjoyed as works of art. They reflect the personality of the artist, although they may arouse thoughts of a well-liked legend or memories of an episode in daily life. Many of the pieces shown here were exhibited in New York through the courtesy of the Canadian Government and sold at St. James' Episcopal Church to benefit Eskimo mission activity.

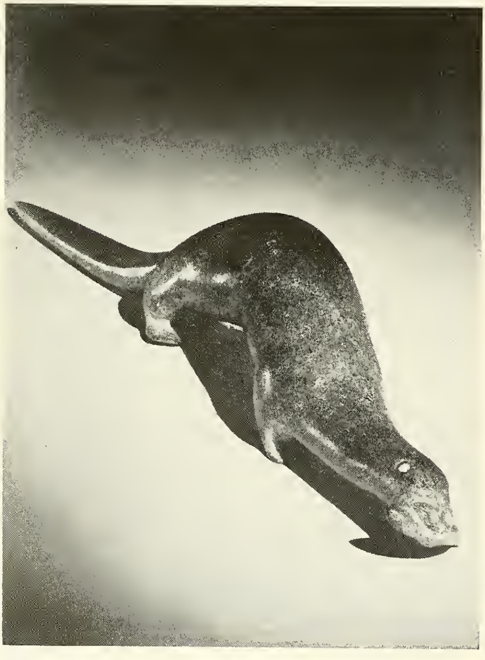


Somnolent young walrus is shown, *above*, curled restfully on a snowy bed. Note accent of inset ivory tusks.

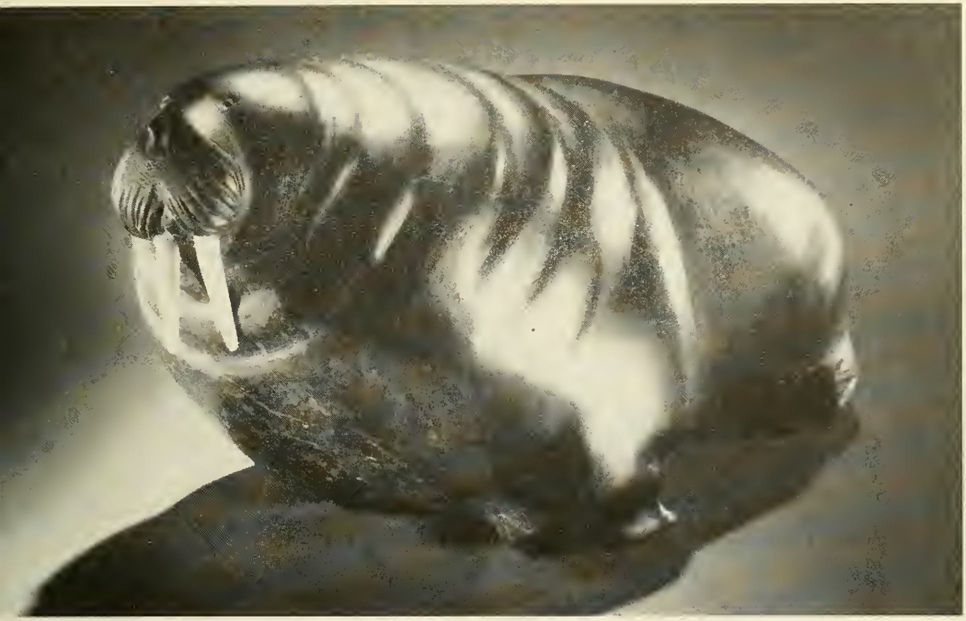
Narwhal, in steatite, sports an ivory tusk, *right*. Piece, by a Povungnituk artist, is from Perry Collection.



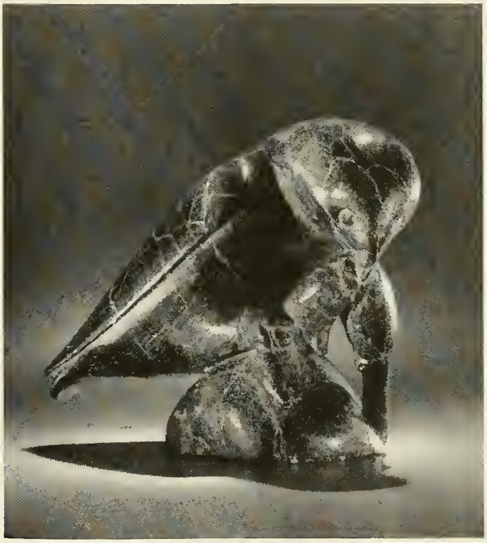
Stolid lines of a musk ox are well captured in this ivory-accented piece by Isapik of Povungnituk.



Flowing motion of an otter, prey in mouth, is deftly conveyed, *above*. The eye is an inset of ivory.

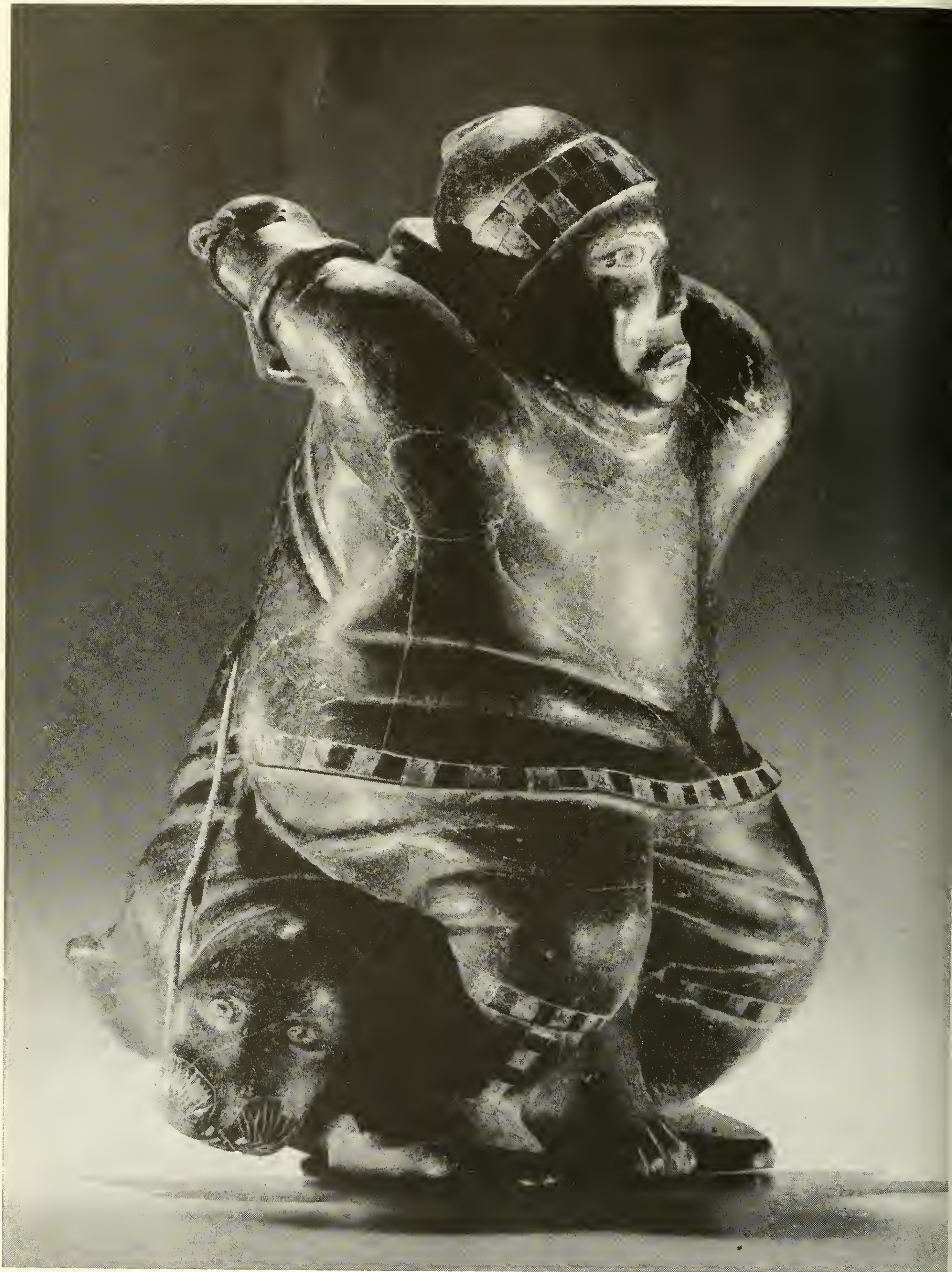


Massive bulk of mature, bewhiskered walrus was rendered in steatite by Eskimo sculptor of Port Harrison.

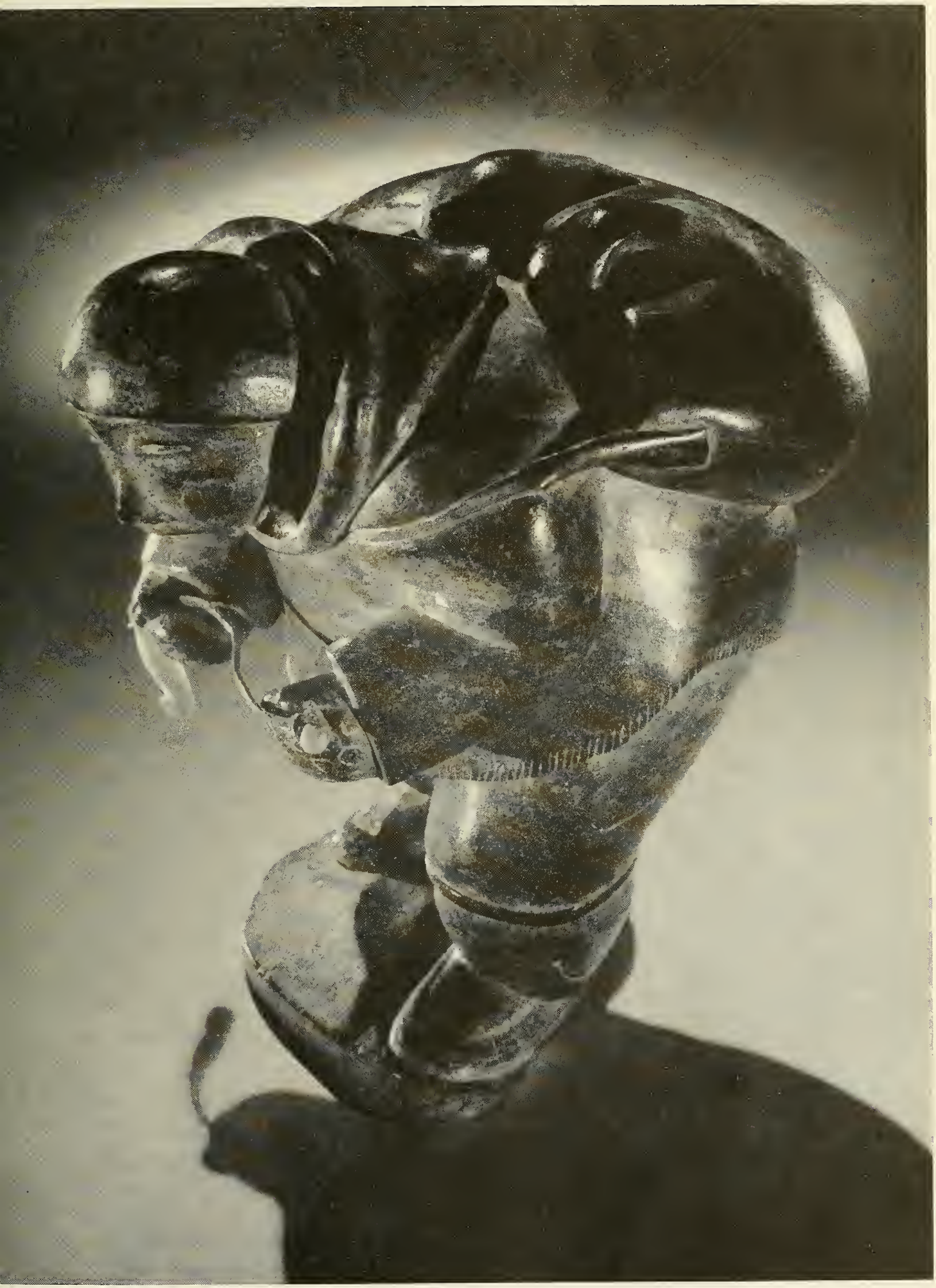


Bird of prey, possibly an owl, clutches a mink in beak and talons. A work by Joanesse of Povungnituk.

Couched reindeer, *left*, carries set of ivory antlers. Serpentine piece is by Kalinga of Povungnituk.

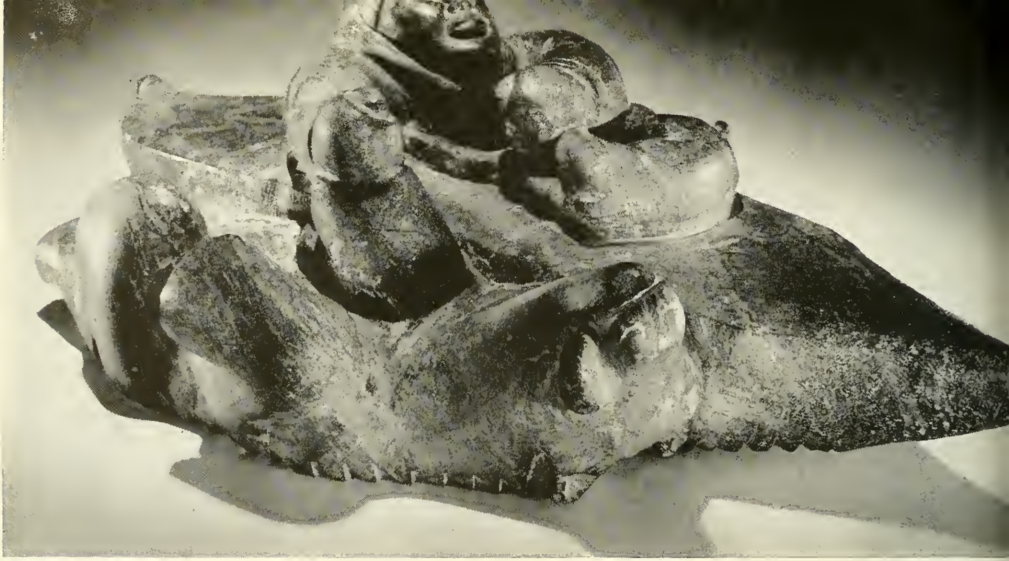


Triumphant hunter hoists the ponderous burden of a slain sea mammal before returning to his winter house.

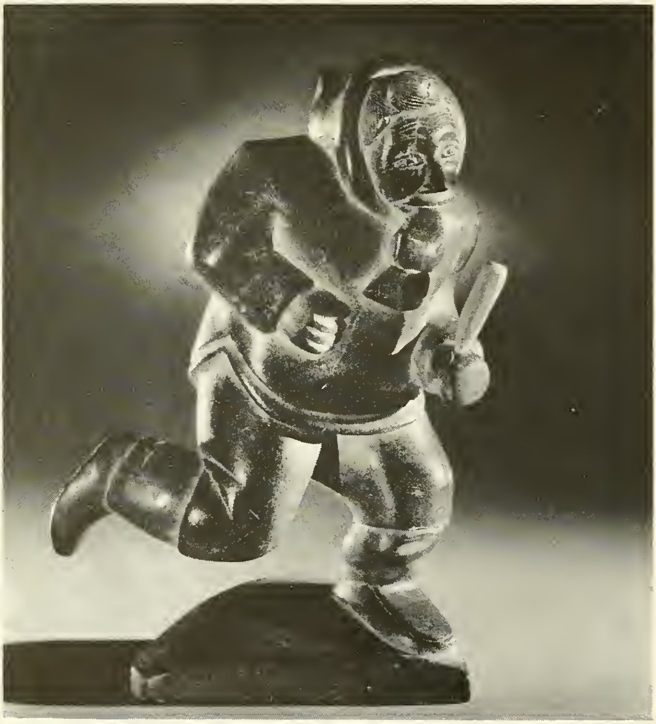


)

atient fisherman, with a simple hook of ivory at end of a thong,
ıns over hole in ice with packful of fish on his back.



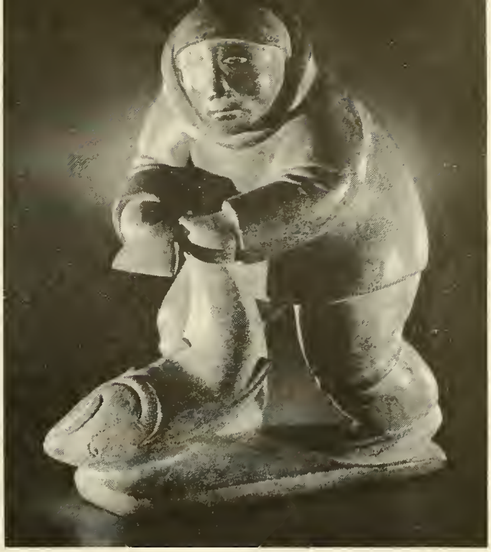
Man in kayak faces dilemma. With dead adult bear in tow and cub in hand on deck, how will he paddle home?



Running hunter, ivory club in hand, may be pursuing seal cornered on the ice. By Tamusseapik of Povungnituk.

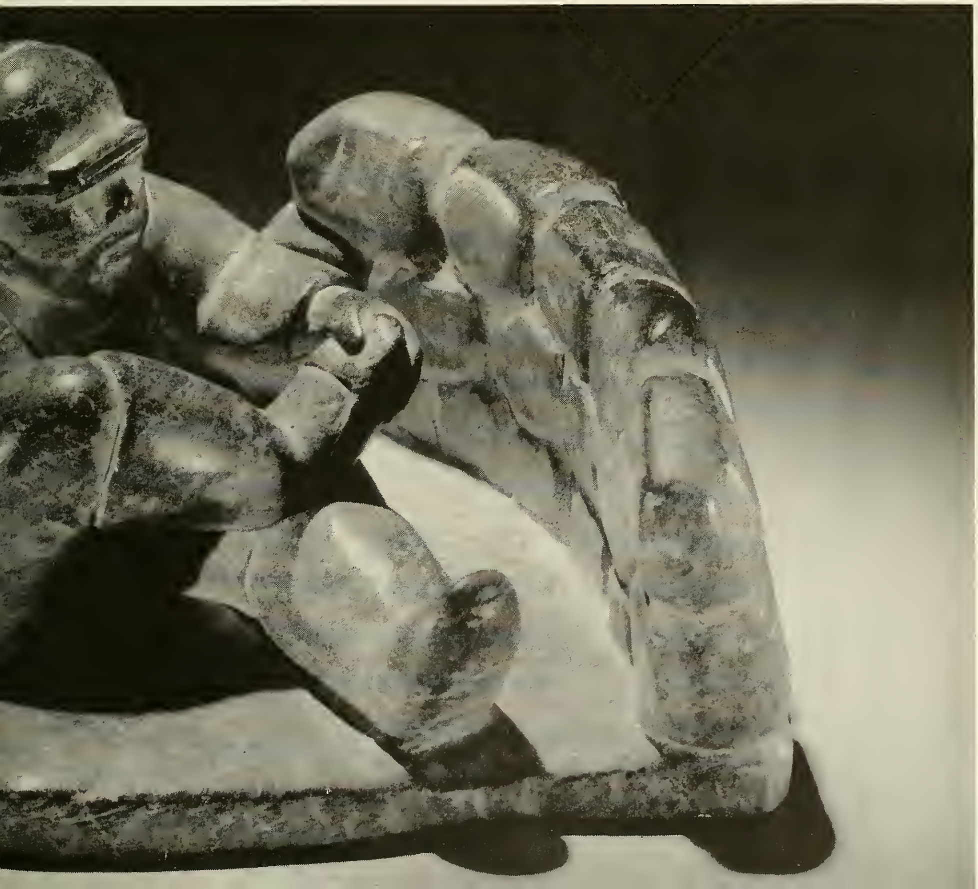
IVE the seasoned hunter a broken file and a piece
of steatite or serpentine. and let him reminisce.
his mood conveys the images of his memory to his
ong and facile hands, the stone takes shape. Some-
ies he holds the work with his feet, the better to
his hands on it. In time, a caribou, musk ox, or
lrus emerges, and the artist smooths the figure with
other stone and with stone dust. When he wishes
drill a hole in a pendant or to inlay an antler or
eye dot, he uses the prehistoric bow drill—twirling
shaft in a socket clenched between his teeth while
nipulating the carving in his free hand. He soaks
finished piece in seal oil for a few days and finally
s it to a satiny luster with his hands. By his shap-
, the Eskimo artist has made one of the less resist-
materials to be found in his resistant world
pond to his concept of something beautiful, signi-
ant, humorous, or awesome; something to be dis-
yed when relatives visit.

There are variations in quality, but it is no wonder
t many modern Eskimo carvings are valued high-
The finest of them proclaim their individuality
th a noble economy of line and display the creative
ve that is a delight to all true lovers of the arts.



Catch of a fat cod promises brief respite from the drive of hunger. Work is by Pootoogook of Povungnituk.

oment of rest behind sheltering snow wall is used
ggled seal-hunter to massage cold feet.



WINTER WOODS

Billions of organisms, constantly attacking nature's trash, insure each spring's greenery

By Jack McCormick

The spectacle of kaleidoscopic autumn color has long since faded from our deciduous forests. Now they are marked by the somber browns, grays, and blacks of naked trunks and limbs, periodically silhouetted against a white backdrop of snow. The vivid scarlets, brilliant golds, yellows, oranges, and the deep violets of autumn are all but forgotten as the leaves lie in a dun-colored carpet on the forest floor. To many, these drifts and windrows of leaves seem to form a lifeless trash heap that requires consideration only when its components clutter a tidy lawn or hide obstacles in a woodland footpath.

Each year, in eastern North America, some ten million leaves drift down from the trees to each acre of the forest floor. These leaves, together with an almost continuous addition of shrub leaves, dried herbs, flowers, fruits, twigs, limbs, logs, and animal remains and wastes, add up to nearly two tons per acre. If this weighty blanket were allowed to lie where it fell, mosses, ferns, wildflowers and tree seedlings would quickly smother, with their light and air cut off. In a few years, the entire forest would be buried in its own wastes. There are relatively limited supplies of available carbon, nitrogen, and other elements essential to the life and growth of plants and animals, and these must be circulated again and again to construct food and tissues. If they were immobilized in a carpet of remains on the forest floor, life above—deprived of these materials—would cease.

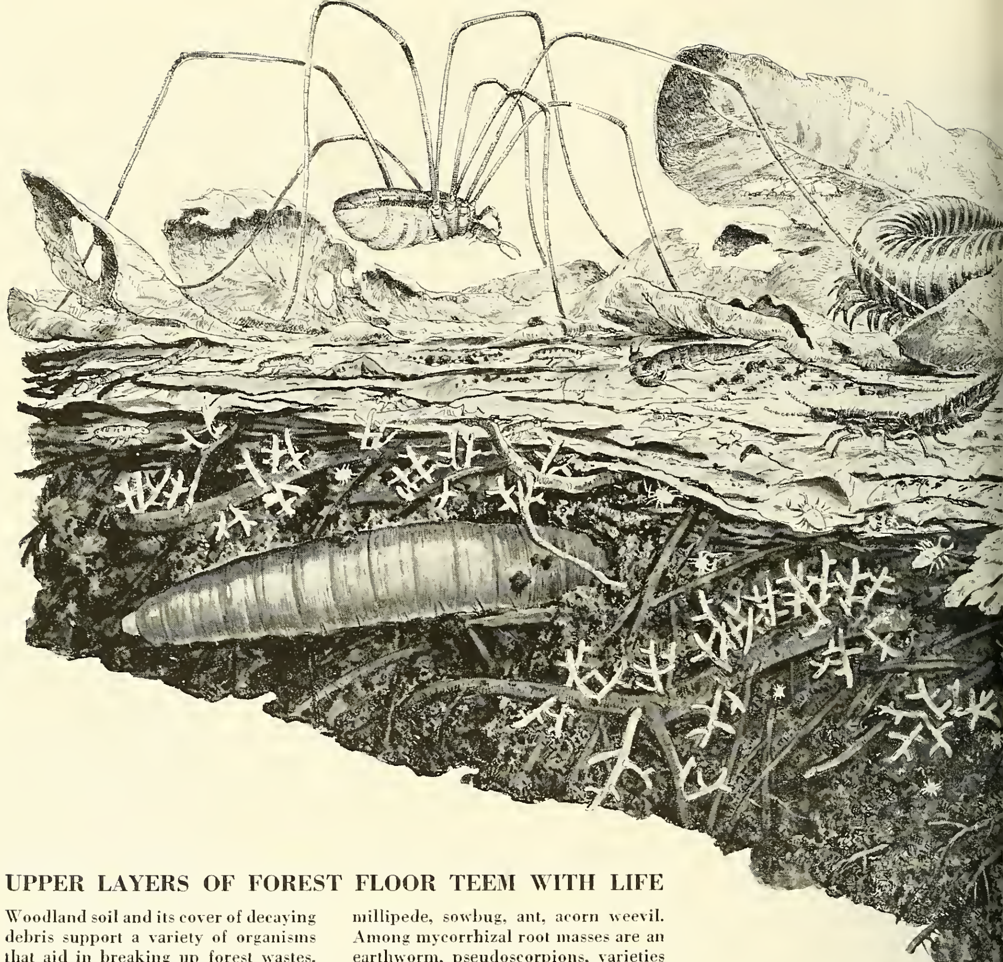
Although few of us have given the matter much thought, it is obvious that these forest wastes are not allowed to accumulate indefinitely. In some way, they must be disintegrated, reduced to simpler chemical forms, and then either mixed with the soil or returned to the air where they again are available to the leaves and roots of green plants.

These processes of reduction are the work of minute plants and animals that make their homes in the forest floor—in reality, the most densely populated stratum of the forest community. The number of organisms that live to a depth of three inches in any square foot of the forest floor can total 104 billion—about forty times the human population of the entire earth! Microscopic fungi (Actinomycetes) make up about fifty per cent of this fantastic mass of life. Bacteria account for another forty per cent, protozoa for five per cent, and true fungi for half of one per cent. Of the total 104 billion organisms in this square foot, animals large enough to be seen with the naked eye constitute only .000004 per cent! To give a better idea of the multiplicity of this life, it has been calculated that in the top three inches of a single acre of forest floor, the microscopic organisms alone may weigh more than a quarter of a ton.

The few relatively large animals that live on the surface of the litter are usually so well camouflaged in form and color that they blend almost imperceptibly into their surroundings. Others shun light and live in the dark recesses below the surface. They pass their lives burrowing through the soft leaf mold and the upper portions of the soil. Because of their secretive habits, these creatures are often termed "cryptozoa," or "hidden animals." Thus, the casual visitor to the forest is not aware of its teeming populace: his eye is taken, instead, by the minority population, such as the vociferous birds, squirrels, or chipmunks.

The floor is both a unique and a vital segment of the forest community. It is doubly protected—sheltered first by the canopy of trees and

Two tons of leaves, animal waste and other debris yearly litter each acre of woodland in eastern North America.



UPPER LAYERS OF FOREST FLOOR TEEM WITH LIFE

Woodland soil and its cover of decaying debris support a variety of organisms that aid in breaking up forest wastes. A few larger forms are, at top, daddy-longlegs, beetle larva, rove beetle, millipede, sowbug, ant, acorn weevil. Among mycorrhizal root masses are an earthworm, pseudoscorpions, varieties of mites and, in the soil, a pupating acorn weevil at the end of its tunnel.

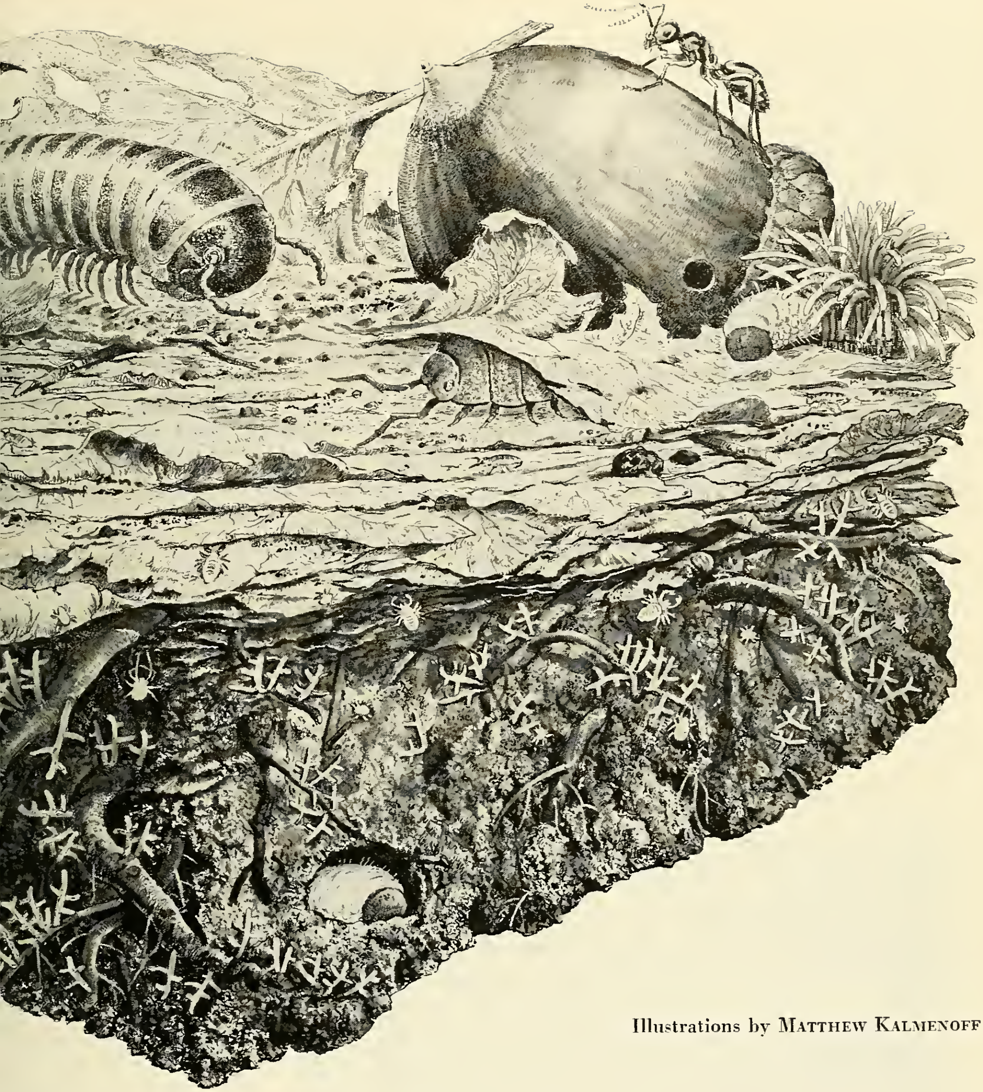
shrubs above, and then by the carpeting of dead leaves that form its upper surface. In climate and structure, as well as in locale, the floor is intermediate between the aerial and subterranean strata of the forest. It is cool, moist, free from wind, protected from sudden changes and extremes of temperature. Its matrix is more compact than that of the upper portions of the forest, but less so than that of the soil. Its atmosphere is low in oxygen, high in carbon dioxide.

During a summer's day, the surface is dimly lit by rays that filter through the leafy canopy above. At night, winter or summer, it is quite dark. Just beneath the surface, there is a diurnal shift from mere twilight to darkness. A few hundredths of an inch deeper, it is perpetual night.

The thickness of the forest floor may vary from a fraction of an inch in one place to a foot or more in another. It responds to changes in the ground's contours and in underlying rocks, to variations in the density of tree trunks and shrub stems, the rate of decomposition of the litter, and the effect of trampling by forest inhabitants. At the surface, it is composed of complete leaves and large leaf fragments, twigs, logs, the excreta and corpses of insects — all mixed with other materials that "rain down" continuously from the higher strata of the forest.

A little deeper, there is a layer o partially decomposed but still identifiable fragments that are intermixe with the excrement of floor-dwellin animals, dead larvae, cast skins, infertile eggs, and the disarticulate skeletons of insects. Beneath this lie a relatively compact but spongy laye of more thoroughly decomposed organic materials in which the individual components are no longe identifiable. This is "humus," brown-colored, colloidal material.

There is usually not a distinct separation between this lower, humu layer and the mineral soil beneath Instead, the "basement" of the community is a zone in which considerable humus is mixed with the minera



Illustrations by MATTHEW KALMENOFF

. The floors of different types of
ests vary considerably in struc-
e, depth, and composition, reflect-
differences in the ages and
sity of trees and shrubs that com-
se each forest, in the floristic and
nistic composition of the litter
ulations, in geological and topo-
phic circumstances, in climate,
l in the frequency of forest fires.
e kinds of trees that compose the
est also exert a strong influence on
characteristics of the floor. The
mical composition of the leaves
and wood of the trees largely governs the rate of decomposition. The leaves of coniferous trees, which have a high proportion of resins, waxes, and similar substances, are much slower to deteriorate than are the leaves of hardwood trees in the same locality. For example, the leaves that fall from tulip trees and other hardwoods that grow in moist coves in the Great Smoky Mountains may decompose in one year, while the leaves of pitch pines on nearby ridges may remain for four years or longer.

FOREST floor life is extremely varied. Numerically, as we have seen, microscopic plants and animals—particularly bacteria, fungi, and protozoa—predominate. Macroscopic animals, those visible to the naked eye, number only about 300 million per acre: about three-fourths of these are sightless invertebrates. Various species of mites predominate among these larger forms. Springtails are usually the only group, other than mites, present in large numbers, although as many as one hundred and fifty kinds of animals may occur in the top three inches of a foot-square slice of forest floor.

Some organisms—such as bacteria, fungi. mites, springtails, and sowbugs—are permanent residents of the forest floor. spending their entire lives there. Populations vary seasonally, however; they are generally highest in autumn and spring, and lowest in summer and winter.

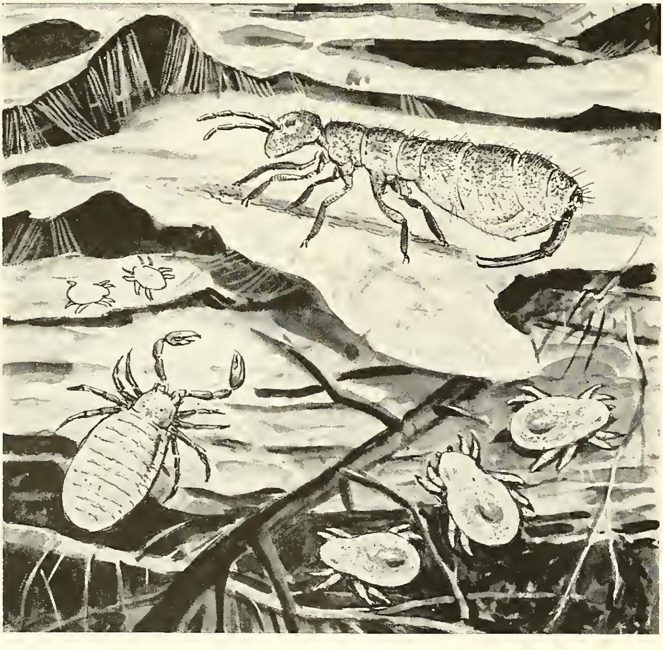
OTHER organisms, such as acorn weevils, spend only one phase of their lives in the forest floor. These species may pupate. estivate, lie in wait for prey or potential hosts. or merely seek temporary shelter in the floor. Still others spend most of their lives above the surface, invading the floor only to feed, nest. or lay eggs.

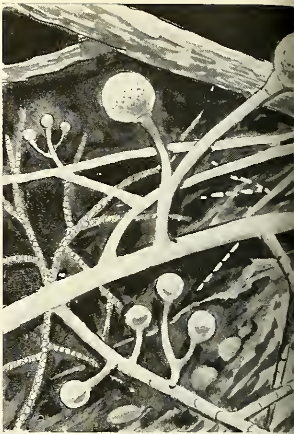
Moles. mice, chipmunks. shrews and ground squirrels are the larger members of the community. The burrows and passageways made by these animals are characteristic features of all forested areas. In addition. snakes. toads. frogs. salamanders. lizards. and tortoises range over the forest floor in search of food.

During the summer. individualized requirements for food, light, warmth, breeding sites, and other conditions operate to sort various species of animals into relatively distinct groups characteristic of different strata of the forest and of different habitats in the region. In winter, however. shelter is the dominant requirement of all species. The selection of a site for hibernation is a serious matter, and each animal is very specific with regard to the type and amount of shelter it requires.

However, selection is rarely so rigid that the leaves or wood or other parts of a particular species of plant are necessary. Even sheets of tin are accepted as shelter by many forms that normally hibernate in the litter. The niches provided by the dead leaves, decaying logs, stumps, and limbs. and the burrows, tunnels, and cavities in the soil of the forest floor offer adequate shelter for a great many animals. Many insects and related animals from fields and meadows and from the treetops. shrubs, and herbs of the forest migrate into the forest floor to hibernate in autumn. Thus. the striking zonations and stratifications of the summer disappear as the animals merge into the forest floor in search of shelter.

SPRINGTAIL (top) and mites feed on organic matter at top of soil and in leaf mold. Pseudoscorpion (lower left) is predator, feeds on the springtails.

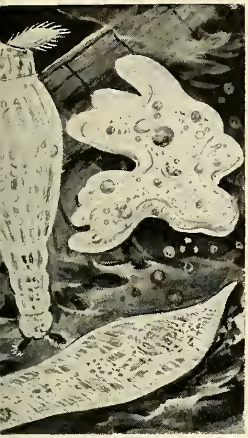




SOIL FUNGUS, when enlarged, revea round fruiting bodies on tiny hypha

Many species show a distinct pre erence for a certain type of shelte such as a well-decayed log. so th these kinds of shelter are inhabit by a distinct group of hibernati animals. Other species seem to ha very simple shelter requirements a apparently hibernate in the first pla that provides an easy entrance enough cover and moisture.

MEASUREMENTS of temperatur by A. M. Holmquist in the flo of a forest in the Chicago regi demonstrate that the layer affor considerable protection against t rigorous winter weather. Before t first snowfall. temperatures benea the layers of dead leaves and insi logs fluctuate with the mean temper ture of the air. Even so, the temper tures of the leaf layer varied on 27°F. and those in logs varied on 17°F.. while the air temperatur ranged from 12° to 63°F.. a vari tion of 51°F. In December and Jan ary, when an insulating blanket snow covered the forest floor, a temperatures dropped as low as −1 F.. but temperatures in the fore floor were never lower than 17° This is well above the lethal temper tures for the hibernating insect Another important aspect of the m croclimate of the forest floor is th while air temperatures varied mo than 30° F. in a single day, the te peratures within the forest floor va ied less than 2°F. Thus. the hibe nating forms were protected fro rapid temperature changes. whic



OPIC ROTIFER, an amoeba, and a
(bottom) live in water film.

extremely damaging to them.
er studies by Holmquist in-
hat individuals of some spe-
arthropods may begin to
e in early September and
ll species are in hibernation
-November around Chicago.
orms were found to sink into
rgy that was so deep that
or prodding did not disturb
n the other hand, some spe-
h as springtails, were found
nost normally active through-
winter. Most species, how-
ere intermediate in their ac-
hey were lethargic, but had
ity to crawl slowly to cover
ey had been exposed and to
active after they were warmed.
species probably are able to
out in their hibernacula and
feed during warm periods of
ter. This ability, however,
orks to the disadvantage of
hat hibernate in the same
ith such a predator. Holm-
intensive searches uncovered
stances in which hibernating
had been deprived of anten-
s, wings, abdomen, or other
y their more active winter
es. More frequently than not,
insects died before spring.
e third week of March in the
region, a few species of in-
come active. Within a few
any other species, including
urning cloak butterfly, bees,
etles, and crickets are out of
ion. A few ants appear in
pril, but the activity of the
colonies does not return to normal until the end of the month. Although the hibernation period varies with different species, in the Chicago region it generally begins in mid-November. In late March, the hibernation period ends. At this time, while the trees are still leafless and sunlight floods the forest floor, the temperatures in the litter may rise briefly to 120° or 130°F., while air temperatures are near 70°. At night, the insulating qualities of the litter conserve heat and allow the litter to remain warmer than the air. These high temperatures appear to be of importance in breaking the dormancy of buds of many low plants and in ending the hibernation of the animals. Creatures emerging from their hibernacula may remain on the forest floor for a few hours or for a day or more before joining the great migration to summer homes that reverses the trend of the previous autumn.

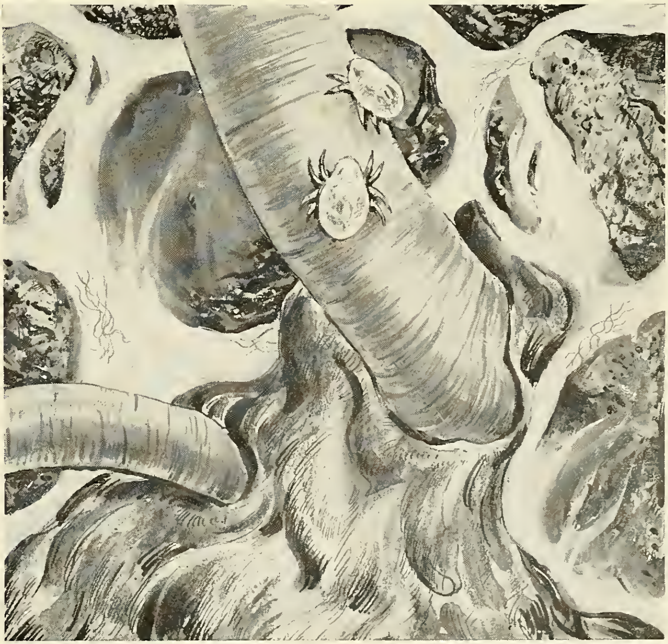
The majority of the forest floor population is concentrated in the upper layer of litter, composed principally of leaves that clothed the trees during the summers past. Fungi and bacteria, the most numerous of the floor-dwelling plants, are especially abundant in the litter, although both forms are also found in the lower horizons of the soil.

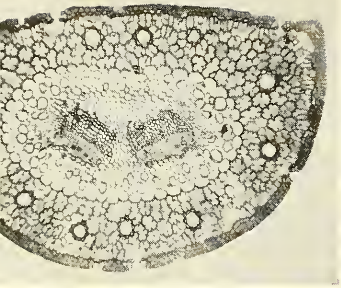
A STUDY in North Carolina showed that sixty-five per cent of the animals of the forest floor are found in the litter; thirty per cent in the first two inches of the soil, where there is considerable humus, and only five per cent in the zone from two to five inches deep.

Many of the microscopic residents of the floor community, particularly the algae, the protozoa, rotifers, nematodes, and flatworms, may be called its "water biota." They are restricted in occurrence to the water-filled spaces within the tissues of leaf fragments or between soil particles, or to the thin water films that adhere to the surfaces of soil particles (illustrations, *above* and *below*). When both litter and soil are completely dry, these water-dwelling organisms either form spores or perish.

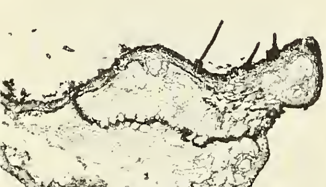
The roots of trees and other plants make up an extremely important component of the forest floor. Soil-forming processes occur most intensively in the zone into which roots release their exudates and from which the

GREATLY ENLARGED soil section shows mites on root (center), which enters humus (below). Dark mineral grains are moisture-coated, and contain algae.

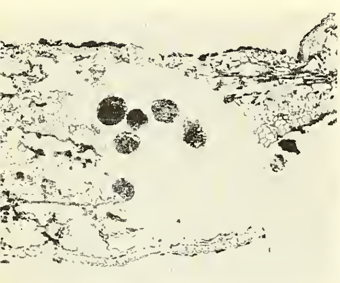




Live pine needle is shown, *above*, in transverse section, magnified 53 times.



Colonies of fungus begin to form at edges. Mites have begun to eat center.



Needle section, magnified 97 times, shows mites' work, deposits of feces.

Decaying needle surface may hold as many as 10,000 fungal conidophores.

roots extract water and nutrients. In addition, the roots compact the soil as they grow, and—after they die—are themselves transformed into humus at various depths in the mineral soil. The tough, resistant bark of dead roots remains intact long after the soft, inner parts have been decomposed, so that pipelike networks of hollowed-out, dead roots thread through the forest floor. These are usually littered with the minute feces dropped by tiny animals. When rainwater drains along the dead root aqueducts, it washes these minute drops of rich fertilizer with it, and carries them to the lower levels of the soil where they are deposited near the living roots of other plants.

During the warmer periods of the year, a majority of the forest floor population engages in round-the-clock feeding that gradually reduces fallen leaves and other debris and transforms them into the gases and nutrients that can be utilized once more by green plants to manufacture food and living tissue.

In southern forests, where the warm season is long, leaves may be completely reduced in less than two years. In the cool, northern forests, the process requires a much longer time. In general, even though the reduction of the litter is more or less in balance with its deposition, the decomposition processes lag far enough behind to allow an accumulation of from two to twenty tons of litter per acre in mature upland forests. The amount of litter in a given forest is not constant throughout the year, however, because of the rapid addition of materials in the late autumn and the gradual reduction of the litter by the floor population during the following spring, summer, and early autumn. In bog forests, where no equilibrium between leaf fall and decomposition exists, dead materials accumulate — in the form of peat — to greater and greater depths with each passing year.

Although the minute forms of the forest floor require the same chemical nutrients as do the larger plants and animals of the forest, only a fraction of the material on which they feed is incorporated into their own bodies. Each day, for example, bacteria will decompose matter that totals from one hundred to one thousand times their own weight. Even the little ma-

terial that they do incorporate is soo
released, for the lives of most suc
microscopic organisms span only
few weeks or months.

The population of the forest floo
is divided into two relatively distin
groups. First, there is a *basic grou*
that is directly responsible for th
reduction of the litter and for variou
changes in the soil. Then, there is
secondary group that consists of para
sites and predators. These secondar
organisms do not enter into the r
duction processes, but rather pre
upon the basic group and serve a
effective checks on their numbers.

The actions of fungi and bacteri
in the basic group results both in th
chemical reduction of plant remain
and in the decomposition of anim
feces and remains. Only a few an
mals—such as millipedes, earthworm
and sowbugs—can feed on plant d
bris before it has been softened an
predigested by bacteria and fung
Such animals, however, play an im
portant role in many forests. It ha
been estimated that, on a single acr
of forest land, more than two ton
of litter may pass through the di
gestive tracts of the millipedes alon
in the span of a year.

Once the initial softening and pr
digestion of the fresh litter has bee
accomplished, myriads of other sma
animals—such as mites and springtai
—go to work. They chew and grind u
the relatively large fragments of litte
digest them, and redeposit them in th
form of minute feces. In the proces
these animals increase the expose
surface area of litter fragments, thu
allowing bacteria and fungi to spee
and expand their work.

Some bacteria are known to b
unable to attack plant materia
until these have passed through th
digestive tract of an animal. Othe
bacteria (and certain protozoa) liv
within the digestive tracts of mite
termites, and other litter-feeding an
mals, where their activities enabl
the animals to digest wood. Thus, i
the course of its reduction, litter mate
rial may be passed through, or be
come a part of, a long and intricat
chain of tiny, interdependent plant
and animals.

The principal agents in the reduc
tion of leaves and other litter to hu
mus are the fungi. By bulk, they ar
the most prominent organisms in th
forest floor: their weight probably ex

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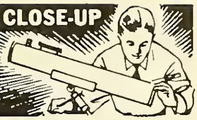

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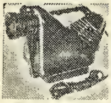

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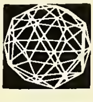

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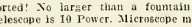

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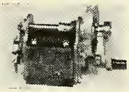

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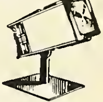

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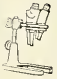

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In charge of vegetation studies at THE AMERICAN MUSEUM, DR. MCCORMICK has done intensive ecological studies of the forest. He treats these fully in a recent book, *The Living Forest.*

ceeds the combined weights of all other floor organisms.

BECAUSE of the abundance of dead organic matter, the prevailingly moist condition, and the relative freedom from disturbance, forested areas support a greater variety of woody and fleshy fungi (the conspicuous shelf fungi, mushrooms, and toadstools) than do cultivated or open areas. Some of these are parasitic on the larger plants of the forest, a few live co-operatively with the roots of other plants, but most are saprophytic—that is, they feed exclusively on the remains of plants and animals.

The larger fungi play an important role in the initial phases of tree decomposition, attacking the dead trunks and the larger limbs. As these huge fragments are resolved into ever smaller ones, other fungi—usually less conspicuous in appearance—act upon them, soften them, and separate still smaller pieces from the larger one, until finally the wood is reduced to a form suitable for the use of a host of small animals. The final steps in the reduction of the complex organic compounds of the wood are probably accomplished by microscopic fungi, such as species of *Penicillium*, by the smallest litter animals, and by bacteria. There is also a succession of fungus forms in decaying leaves, but the majority of the leaf-colonizing species of fungi are microscopic.

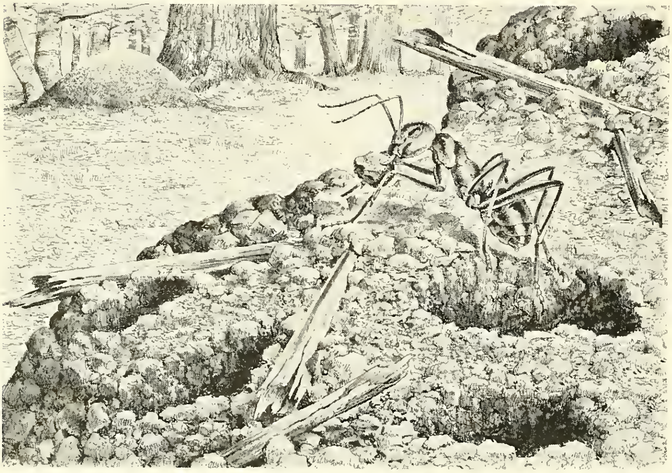
Certain fungi that inhabit the forest floor penetrate the living roots of trees, shrubs, and other plants, causing structural modifications. These can take the form of premature termination of growth (stunting), and the degeneration or non-production of root hairs. However, such an association of root and fungus—known as a mycorrhiza—is apparently beneficial to both the fungus and its host. The fungus seems to derive food from the root: in turn, the threadlike hyphae of the fungus gather water, minerals, and other nutrients—particularly compounds of nitrogen—that are absorbed by the roots of the host.

Most of the forest floor bacteria concentrate on the decomposition of cellulose, lignin, and related compounds that occur in the woody portions of the litter. Some bacteria work to decompose proteins, chitin (found in the remains of insects and other small animals, and in fungal structures), and similar complex nitrogen compounds into simpler ones. These simpler compounds form the principal sources of nitrogen for the trees and other green forest plants. Still other, free-living bacteria—especially species of *Azotobacter*—are able to take nitrogen from the air and combine it with other elements to form compounds that plants can absorb. The work of these nitrogen-fixers, however, is probably of little importance because the forest humus is already rich in nitrogen recovered from plant and animal remains and wastes.

ALGAE are often abundant in th forest floor. Aerial forms ar found on rocks, tree bases, and twig Surface forms live on or just beneat the surface of the litter or soil. Sul terranean forms may also be found i the water films around and betwee soil particles, but these are largely, not entirely, surface forms that hav been carried into the soil by rai water, or buried accidentally b animals. These latter algae, restin below the lighted zone of the fores floor, can neither manufacture foo nor reproduce. They are importan then, chiefly as food for litter- an soil-dwelling animals, and as an add tional source of organic matter whe they die and decompose.

The surface forms of algae, hov ever, consolidate the soil in bar areas, afford a seed bed in whic small seeds can readily germinate an provide a source of food for many c the small litter animals.

SOME floor-dwelling animals fee upon the myriad of fungi tha thrive on the carpet of decomposin organic matter. They check the de velopment of the fungi, which othe wise might clog all the air space within the soil and develop into hard, impermeable mat of ramifyin hyphae on the soil surface. Mite springtails, beetles, thrips, and gnat are included among these fungus eaters, who thus occupy a positio among the secondary group mer tioned earlier. But the lines of div sion are not very distinct. Othe animals, such as certain mites, fl larvae, and some beetles, feed on th feces that fall from the aerial portion of the forest above. Still others ea the bodies of dead or dying animals and thus belong to the basic grou Spiders, daddy longlegs, centipedes pseudoscorpions, many beetles, an some mites are among the lions an wolves of the forest floor: they pre indiscriminately on herbivores, th saprophagous species that feed o dead matter, or on other predator forms. Many species of floor animal are omnivorous. One observer, afte studying the forest floor fauna, con cluded that a typically omnivorou animal "may gnaw or suck sap from a growing plant, browse on verdan vegetation, gnaw the carcass of

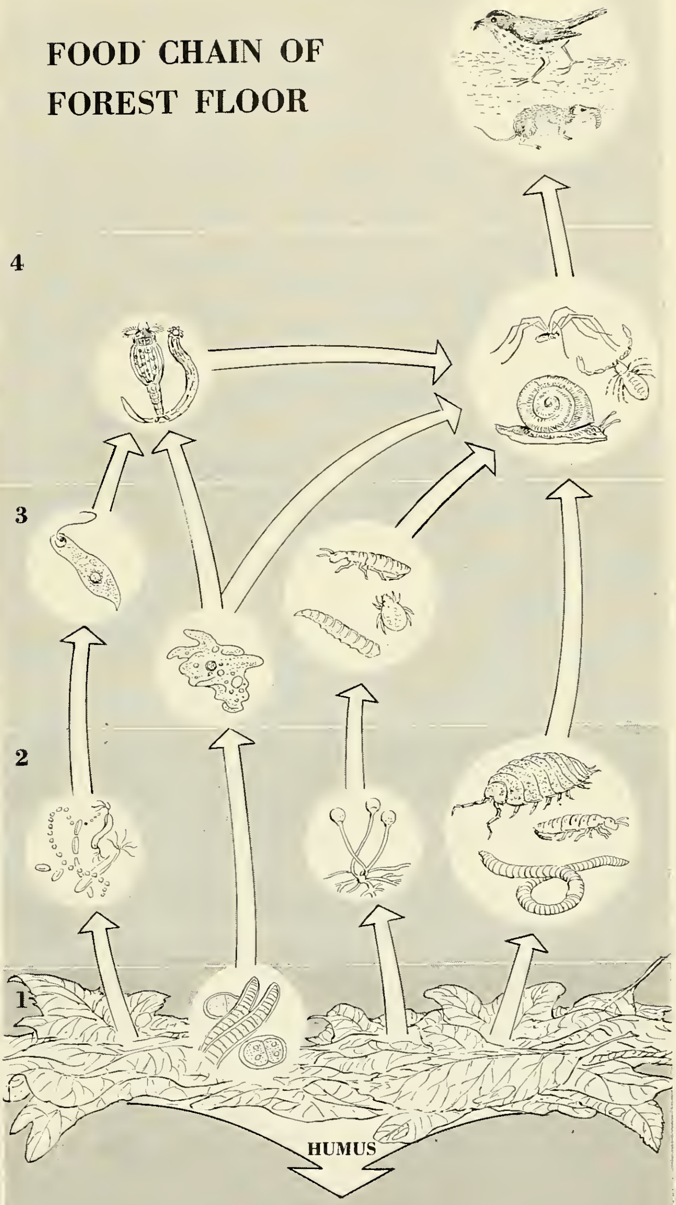


MOUND-BUILDING ANTS "cultivate" th soil, move many tons to surface yearl

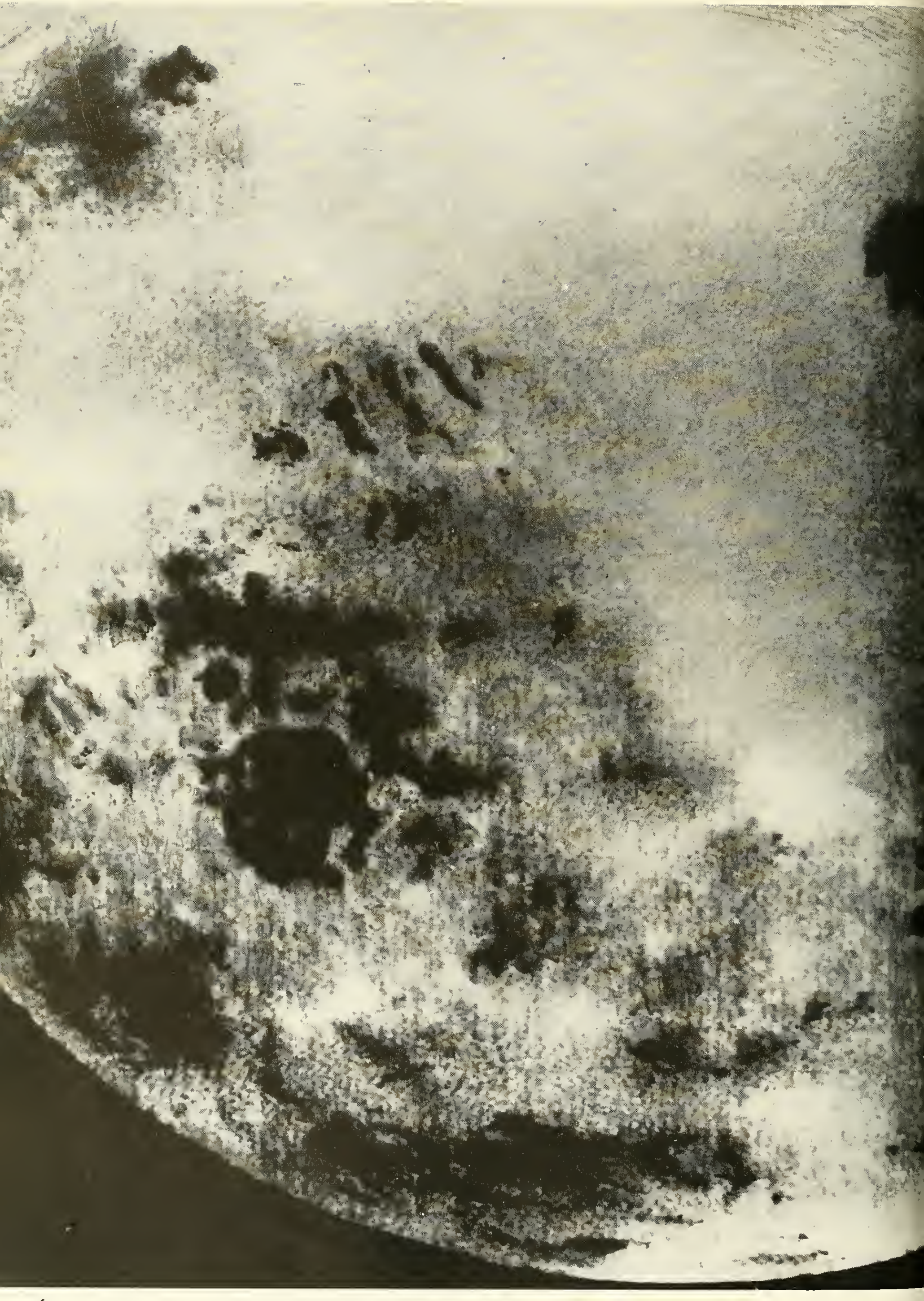
imal, eat part of a fungus,
en] devour a portion of a
p.' " Thus, such omnivorous
night be assigned to the basic
ı one moment, and to the
y group in another. Pro-
he most numerous and the
animals of the forest floor,
nost part are members of the
y group. The vast majority
nter directly into the process
reduction: instead, they feed
ria and are thus instrumen-
miting bacterial populations.
nportant secondary effect is
l by the floor animals' cease-
ch for food, their mating and
activities, and their endless
and goings. In the course of
activities, they dig and main-
naze of holes, passageways,
ries that penetrate every por-
the litter and adjacent soil.
iniature highways, paths, and
s make the soil more porous,
facilitate the atmosphere's
ion of the soil, and provide
and reservoirs for water.
worms, which may number
an half a million per acre in
rests, ingest mineral particles
ith leaf fragments, mix them,
s the mixture through their
Their casts impart a crumbly
e to the soil. The worms also
ineral soil particles over the
of the forest floor and pull
gments down from the surface
soil. Their burrows improve
ation and water penetration.
ugh earthworms are generally
zed as efficient "cultivators" of
ants have rarely shared this
on. Yet, where they are abun-
ne ants' work may compare
ly with, or even surpass that
ıworms. For example, it has
timated that. on a single acre,
ıy bring a half-ton of soil to
ace each year.

s, hour by hour, billions of
ıute organisms—living, work-
producing, and dying in each
the forest floor—are engaged
never-ending activities that
churn, disintegrate, and re-
e forest's wastes and remains.
atural "factory" receives its
terial, for the most part, in a
massive delivery with the leaf
autumn. But, throughout the
asons, the vital work goes on,
r woodlands remain verdant.

FOOD CHAIN OF FOREST FLOOR



Food relationships begin in forest litter (band 1, above), where many algae live. Microscopic decomposers (band 2) eat litter. Predators (in band 3) in turn eat the decomposers. Secondary predators (band 4) feed on predators, are themselves food for vertebrates such as shrews and birds (top). Humus (bottom) stays after decay, mixes with the soil.



ON THE COSMIC BRINK

e twenty-seven months since Sputnik I have seen vast strides

By Franklyn M. Branley

October 4, 1957, the day that
Sputnik I was put into orbit, a
frontier opened for mankind.
he first time, humanity had not
oroken free of the close confines
e earth but also had come to
s an inkling of the great strides
ed before man attains a better
standing of the earth's total,
c environment.
ce then, observations of the or-
variations of Vanguard I, the
grapefruit-sized satellite that
probably remain in orbit for
2,000 years, have enabled geo-
ists to refine their impression
e size and shape of the earth.
rer I, in turn, disclosed the Van
belts, hitherto unknown regions
al radiation lying in space just
d the earth.
ik III, in its epic flight last
n, carried a camera to that part
moon man has never seen. The
's back was photographed while
III was some 280,000 miles
the earth. The exposed film was
ped inside the satellite, the pic-
was scanned electronically and
the scanning signal transmitted to earth after the satellite had returned to within 30,000 miles of the earth.

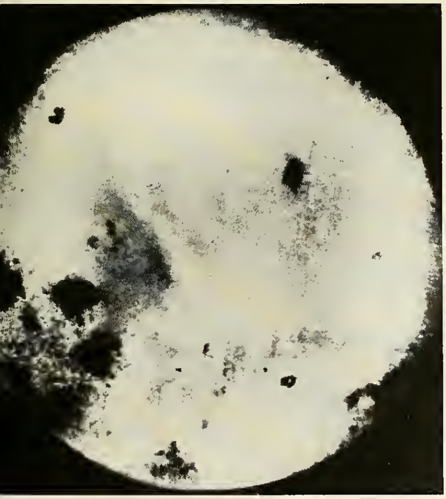
Associate Astronomer on the staff of The American Museum-Hayden Planetarium, Dr. Branley is a regular contributor to these pages.

But the exploration of outer space during the past twenty-seven months has not been limited to the use of such super tools. Indeed, while man-made satellites have obtained much important data about the density and temperatures of the upper air, about the concentration of positive and negative ions, and about the shape of our planet, these costly devices are considered by many to be the glamor gadgets of space exploration. Many critics claim—and there is some basis for their contention—that the work horses of space research are the solid-fuel rockets—small, efficient devices that carry instruments to moderate altitudes and then fall to earth; rockets such as those that have carried aloft large, radio-reflecting balloons, and that have released voluminous clouds of sodium vapor high in the ionosphere.

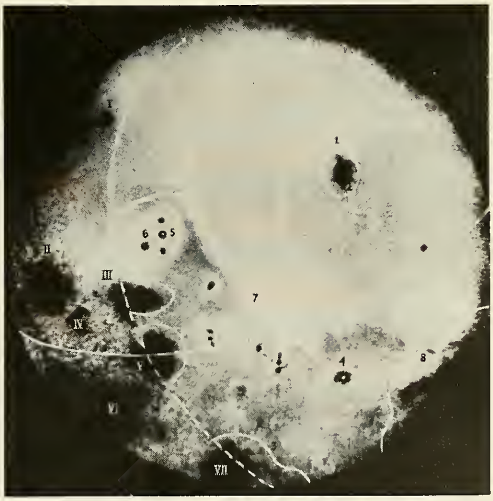
During the past few months, also, telescopic photographs of the sun have been made from balloons that reached vantage points ten miles and more high—far above the murky, congested, and shimmering depths of the lower atmosphere. Venus has been the target of the latest such attempt, using a manned telescopic camera carried by balloon to an even higher elevation—over 80,000 feet.

During the flight of Lunik II, a Soviet satellite launched last September, a cloud of sodium vapor was released from the rocket carrier, producing the sight seen on the next page. A fuse was timed to set off the orange-yellow cloud when the satellite was some 90,000 miles from the earth on its moon journey.

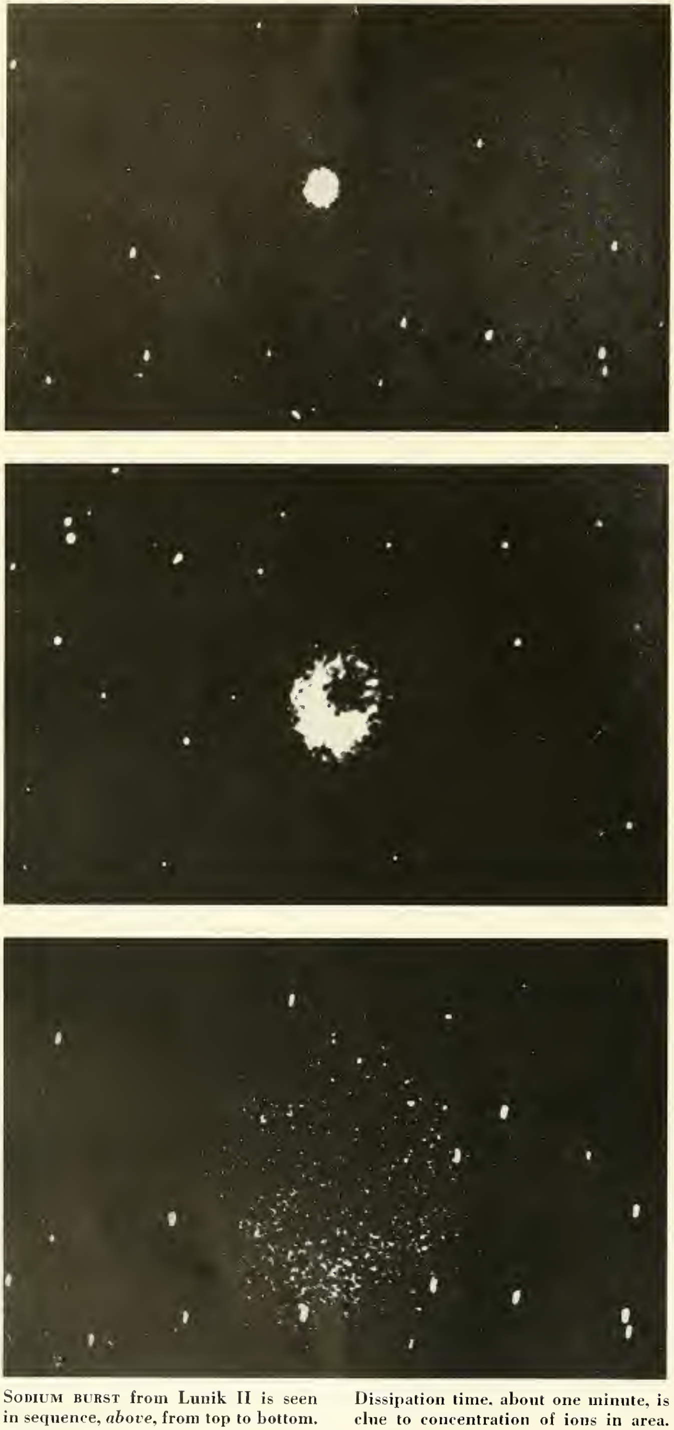
The rate at which such clouds disperse is related to the concentration of ionized particles in the area. A series of experiments conducted in the U.S. last fall employed a similar



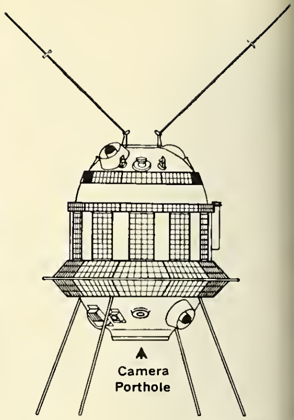
eup of moon's back, *left*, was made with 500 mm.
in Lunik III. Wave pattern is due to scanning device.



Long shot of moon, *above*, was 200 mm. job. Area to right of dotted line in annotated print was previously unobserved.



Sodium burst from Lunik II is seen in sequence, *above*, from top to bottom. Dissipation time, about one minute, is clue to concentration of ions in area.



Lunik III, seen in Soviet sketch, ha six aerials, camera hatch at the botto

technique to study the drift of air a altitudes of fifty to a hundred an fifty miles. Rockets, launched fron Wallops Island, Virginia, carrie loads of sodium a hundred and fift miles above the earth. The loads the exploded, producing large sodiun vapor clouds with long, tapering tails These test clouds, carried along b the winds, were dispersed by the explosion and interaction with th ionized particles that exist at tha altitude in the upper air.

EARLIER last fall, another and different sort of launching occurred at Wallops Island. A huge metallic-coated balloon was carrie aloft by rocket while tightly folded When altitude was attained, the balloon was automatically inflated. I became a sphere, one hundred feet i diameter, that glowed more brightl than the stars in the twilight sk along the U. S. East Coast—second i brightness only to the moon—an alarmed observers from the Carolina to Maine (photo, *right*).

Research into the nature of oute space will increase in tempo as th multitude of project plans now waiting implementation get off the ground Metallic balloons, sodium clouds, picture-taking satellites, and half a hundred other ventures are to be undertaken. Amateur observers shoul be on the alert, for many of thes endeavors can be observed by the interested layman, as in the exampl here illustrated—the brightly glowin balloon, captured on film by Shirle Gale, a talented amateur astronome

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NATURE AND THE MICROSCOPE

By Julian D. Corrington

Introducing the microscope and the science of microscopy to the reader is like taking him into an immense gathering of persons of all races and creeds and trying to acquaint him with each one in turn, including a bit of biography for every individual. For the subject embraces an enormous territory and invades almost all aspects of modern science and industry. Such a broad statement of coverage indicates also the great importance of this instrument, and our own belief, backed by that of many others, is that no one today can afford to be without at least an elementary knowledge of this field.

Among topics to be discussed in future installments of this department—new to readers of Natural History—are the various kinds of microscopes and the uses for which each is designed—some generalized, some specialized; how to buy a microscope—considering such decisions as the purposes for which it is intended, and the price; what a microscope can do for the owner; and the anatomy of the compound microscope, including the functions and upkeep of the various parts, and care of the operator's eyes. We shall also present a program of work for those who already possess a microscope, with suggestions for beginning the manufacture of slide mounts as the nucleus of a collection, and indications as to what sorts of information can be obtained from them.

Before man invented any sort of appliance to augment his vision, he knew nothing at all concerning the microcosm—the world of the finer construction of matter that lies all about us and within us, and of forms of living beings too small to be seen with the unaided eye. There were a few glimmerings, such as the rare insight of Fracastoro of Verona, who, in 1546, postulated small bodies that made up a *contagium vivum*, floating in the atmosphere—the pathogens that we now call bacteria and viruses. The bacteria were, in fact, discovered in 1676 by the great Dutch amateur microscopist, Anto van Leeuwenhoek, but two centuri were to pass before they were identifie by Pasteur in the years 1865-188 as causal organisms of specific diseas Leeuwenhoek also was the first pers to see protozoa, yeast, sperm cells, r blood corpuscles, and a multitude other microscopic objects, opening an entire new vista of the world we i habit. Robert Hooke discovered a named the cell, the building block organic matter, in 1665.

The microscope was a necessary i vention before these observations we possible. Discoveries came slowly first, but grew with an ever-accelerati momentum, leading to our present e haustive, but by no means comple information about the invisible porti of our environment. First came a broa ening of knowledge in the biologic sphere. Many people today think on of this science when the microscope mentioned, but that notion is far fro correct, since this clever appliance an important tool in all of the scienc both pure (as geology or genetics) a applied (as medicine or engineering and in all of the basic industries. T production of steel and other meta rubber, textiles, paper, paints, foo drugs, cosmetics, and a long list other manufactured items is based the microscope as the determiner particle size, of purity of the produ of correctness of alloying or blendin of adulteration, and of many oth criteria essential for a proper fin product. Competition keeps major fir on their toes, and they pride themselv on their technical laboratories and sta of trained scientists. Indeed, the mic scope is the king of instruments.

A pertinent query at this point mig be: this is all very well, but what c the average amateur expect to obta by way of information or education, f profit or pleasure, if he takes up micr copy as an avocation? Does he dare embark on a subject as large and a vanced as is this one in the mi twentieth century? The answer is emphatic "Yes." There is a great de that one can learn and much that can do, and our aim in this departme

:. Corrington's column appeared gularly in Nature Magazine for arly twenty years, and can now be lowed in the combined magazines.

suggest the methods. The desire ıe person may be that of laying a ıdation for a career in some field ience or industry—Smith may have ı to study the histology of blood, n to delve into crystal structure, Jones to take up scientific crime tion. Another may decide on ɔscopy as the most worthwhile of ies, and begin to make a collection des. But perhaps the majority will undecided. They may think they l like the subject, but have no al realm of interest, and are thus tain whether to make a beginning w to go about it.

r advice is to follow this series ticles and try out a sampling of e divisions. We shall be making of plants and their parts, of bac- and diatoms and protozoa, of in- and mites, of textiles and paper, emical crystals and metals and stones, of sands and soils, rocks, als and fossils, and of various al tissues and organs and blood. with these preparations will go nation about the microscope itself f such accessories as illuminants microtomes.

a while, then, the beginner should the whole field. Only by doing so e be able later to decide upon a lty. Having once constructed a ion of slides in every province, is no point in continuing to gen- e, for the experimenter will have e absorbed by the possibilities of one branch, and can go further e one of his choice. Thus, as an ple, the owner of a microscope at first be in the area of general e. From there he may move to y, then to histology (microscopic my), and, perhaps, wind up in logy—the histology of the nervous n. He may pursue these enquiries hobby, or he may become a dedi- scientist. By no means all of the butions to a subject have been by professionals; there have been successful amateurs who have important discoveries and have hed their findings. And by no s are all microscopists men. In- there are many recognized women scopists — both professional and ur—at work today.

whether one follows microscopy rofessional end or prefers to con- one's efforts solely to learning the things that the microscope eveal, there is a vast amount of ure to be obtained from work of haracter. It is fun, it is worth- , and it is important, and keeps one abreast of many matters of value in our present complex civilization.

To begin, one would do well to have an introductory book, and I am compelled to recommend one of my own, for there is none other available. There are many fine works on the microscope and others on microtechnique, and we shall have occasion to mention them later but, for a general introduction to the field, I must blushingly cite *Exploring With Your Microscope*, McGraw-Hill, 1957.

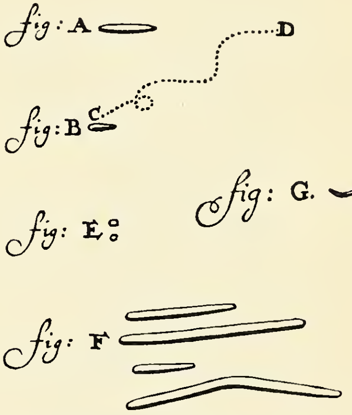
A Project in Engraving Methods

One of the simplest and easiest of subjects with which to inaugurate a slide collection and learn methods is also one of the most interesting. The necessary equipment consists of a few blank microscope slides and cover glasses, a medicine dropper (called a *pipette* in microtechnique), a bottle of xylene, and one of a mounting medium.

Microslides are thin strips of glass, three inches by one inch, polished and with ground edges. The glass must be of a special quality, perfectly clear and free from bubbles or striations. Seventy-two of these slides are packed in each box. *Cover glasses* are exceedingly thin squares, circles, or rectangles of glass of the same quality, and are sold in three thicknesses: "0," "1," and "2." "0" is the thinnest and hence the most expensive; circles are more costly than squares; rectangles are employed only in those special cases in which the whole area of the slide must be covered, as in serial sections of embryos. Sizes are specified either by the metric system or in inches. The best cover for all average purposes is a number "1" square, 22 mm.

Xylene is a colorless, oily coal tar derivative that has wide usage in microtechnique as a *clearer*. The principle is the same as that used by American pioneers before glass was available. They rubbed pork fat on heavy brown paper to make it translucent and this served as a window covering that would admit daylight to the interior of a cabin. We shall use xylene in just this fashion, "oiling" our test pieces of paper so that light from the microscope mirror can be transmitted through them and up through the lenses to our eye. Xylene is said to *clear* the object. It will mix in any proportion with the mountant, as well as with pure alcohol, but it is intolerant of even the slightest trace of water. To see what happens when any water is present in a specimen, take a half-inch square of newspaper, wet it, allow it to dry partially—until it is only damp—then add a drop or two of xylene. A milky, opaque mixture, ruinous to a slide preparation, results.

A mounting medium, or *mountant*, must combine several qualifications. It must be in liquid form for use, but must then harden to a solid to seal the cover glass permanently to the slide. It must be colorless and chemically neutral and have the same refractive index as the glass of the slide, cover, and microscope lenses. The original material, still widely used, is Canada balsam, a natural resin, dissolved in xylene. It is kept in a balsam bottle that contains a glass applicator rod. Balsam tends to yellow with age and to become somewhat acid, hence microscopists place a few small pieces of marble in their balsam bottles. The calcium carbonate contained in marble tends to neutralize the acid. In recent years, a water-white, synthetic and neutral mountant has been preferred as more uniform and reliable. It is obtainable in small bottles equipped with an applicator rod. Various manufacturers have their own trade names for these mountants.



Van Leeuwenhoek drew bacteria found in the human mouth in 1695, *above*. Modern photograph, *below*, shows a sputum smear.

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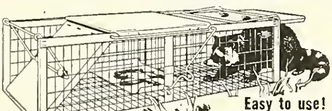

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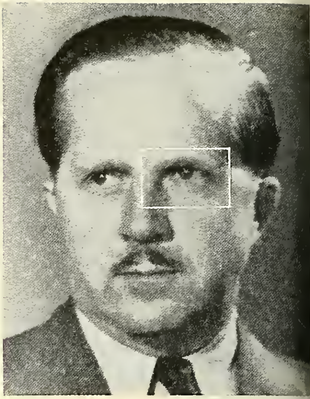
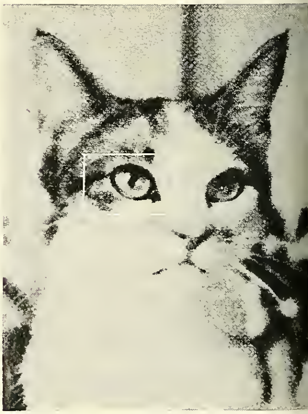


EYE in newspaper halftone, *above*, is pattern of dots when magnified, *right*

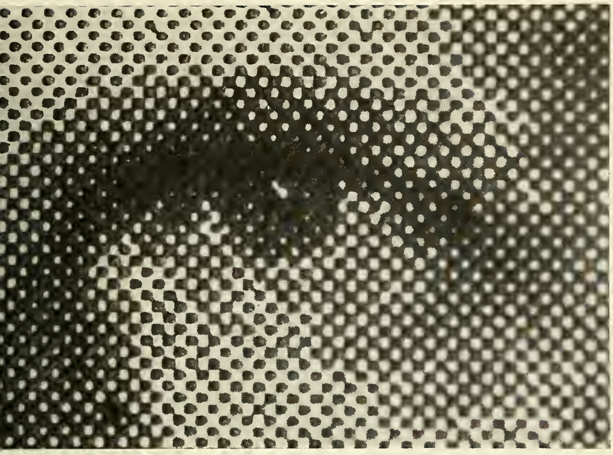
Now select a number of illustration from newspapers and magazines including at least one of each of the following: a black-and-white newspaper drawing, such as a comic strip; a black-and-white drawing from a slick pape magazine—perhaps a fashion sketch; black-and-white newspaper photograph and one from a slick magazine; a colo picture from the Sunday newspaper comics; a color picture from a slic magazine; and, finally, a postage stamp.

Affix the postage stamp to the cente of a clean slide and allow it to dr thoroughly. Cut a half-inch square from a portion of each of the other samples. Be sure they all show considerable detail. Place them on separate slides.

Add one or two drops of xylene t each specimen and allow the pape fibers to soak up this oily material. Then add one large drop of the mountant. The xylene will evaporate mor

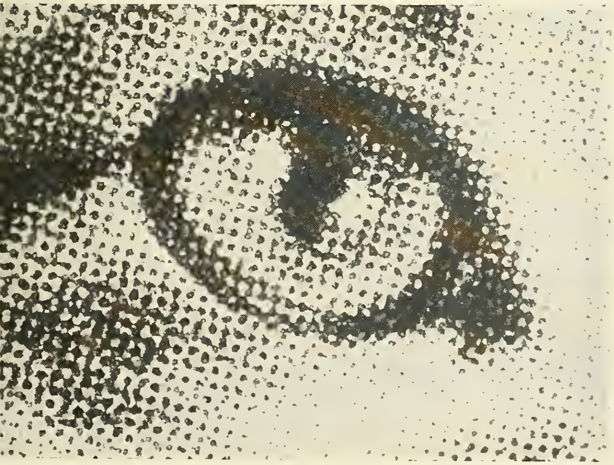


EYE in four-color photo, *above*, forms multiple dot pattern under microscope



than water, and the paper will resume its opaque appearance. e mountant before this happens. ace a cover glass on each prep- in the following manner: grasp by the edges between thumb efinger and lower it over the nt on a slant, so that one edge cover touches the slide just be- ne square of paper. Then let wing the cover to fall gently into The mountant will flow evenly all the space beneath the cover, quantity is correct. Too little nt will result in air sucking in he cover to make one or more ubbles; too much will cause the mountant to flow out be- he cover, producing a messy A bit of experience with these specimens will soon acquaint the r with the proper quantity of nt to use—less for very thin objects, and more for the thicker objects.

The xylene gradually evaporates around the edges of the cover and the mountant solidifies. This may take from one to two weeks if balsam is used, and a shorter time if synthetic mountants are selected. The slide may be used at once, but care must be taken to keep it flat and to remove the spring clips from the microscope stage so that they do not inadvertently contact the edge of the cover and draw out and smear the mountant. When completely hardened, the slide should be polished and labeled. Any excess mountant beyond the cover may be scraped off with a small knife blade—it will flake off readily when dry—but use caution not to touch the edge of the cover; these thin glasses shatter readily. Labeling may be done with a special ink that writes on glass, or by affixing a gummed paper label, applied like a postage



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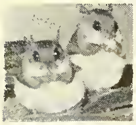

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FIRST inspect the black-and-white mounts under the low power of the microscope. The fibers of newsprint are much coarser than those of the slick paper of magazines, and the engraving work is correspondingly coarser. These are etchings made from a plate of zinc commonly called a "cut" or a "block." The material to be reproduced is left at the original level of the plate, while that surrounding it is removed, a method known as relief. No screen appears in the magnified view of a line drawing. When a newspaper *photograph* is examined, however, a screen is seen. The photograph has been broken up into a series of dots—an example of the halftone process. The original picture is rephotographed upon a sensitized plate through a screen made by fine parallel rulings on glass, the gratings of which are then filled with black. Halftone screens are designated according to number of lines per inch. For coarse newsprint there are 60 lines; for magazine black-and-white, 120 to 150; for superior color work, 150 to 200. A 60-line newspaper halftone will contain 3,600 dots to the square inch, representing the space between the ruled squares. The dots in these squares will be of various shades of light and dark, according to the original subject. When seen by the unaided eye, they run together to reproduce the original picture. The microscope shows such a reproduced photograph to be actually nothing an optical illusion!

When we turn to the colored ill trations and view them magnified, see that the face of the pretty girl the magazine cover is just a meani less series of colored dots. Separ halftones are prepared for those pa of the original that are red, yellow, a blue, using filters on the camera. Wl these are printed, with their app priate inks, not only are the reds in original rendered by red dots, the y lows by yellow dots, and the blues blue dots, but when two or more these are superimposed, other col are reproduced—that is, red plus yell makes orange. This is readily appar under magnification. Those who f this subject of interest should read article entitled "Photo-engraving" the *Encyclopaedia Britannica* for f ther information.

In our next installment we shall ca the microtechnical procedure a s further by describing how to prep mounts of whole insects and their v ious parts.

This list details the photographer, art or other source of illustrations, by pa

COVER—Lee Boltin.
4-5—Nicholas Amorosi.
9—University of Pennsylvania Library.
10—Carl Zeiss.
11—Photo Oeuvre, Notre Dame, Strasbourg.
12-13—AMNH.
13—bottom, Carl Zeiss.
14-15—Helmut Wimmer, AMNH.
16-29—Sven Gillsäter.
30-31—AMNH; except 31 top, Photograph from the Mount Wilson and Palomar Observatories.
32-33—Star Map, after Henry M. Neely.
34—Nancy Gahan, AMN
35-47—Lee Boltin.
48-51—Matthew Kalmen AMNH.
52—Bryce Kendrick.
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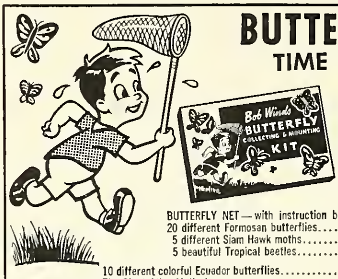

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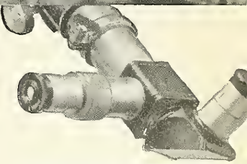

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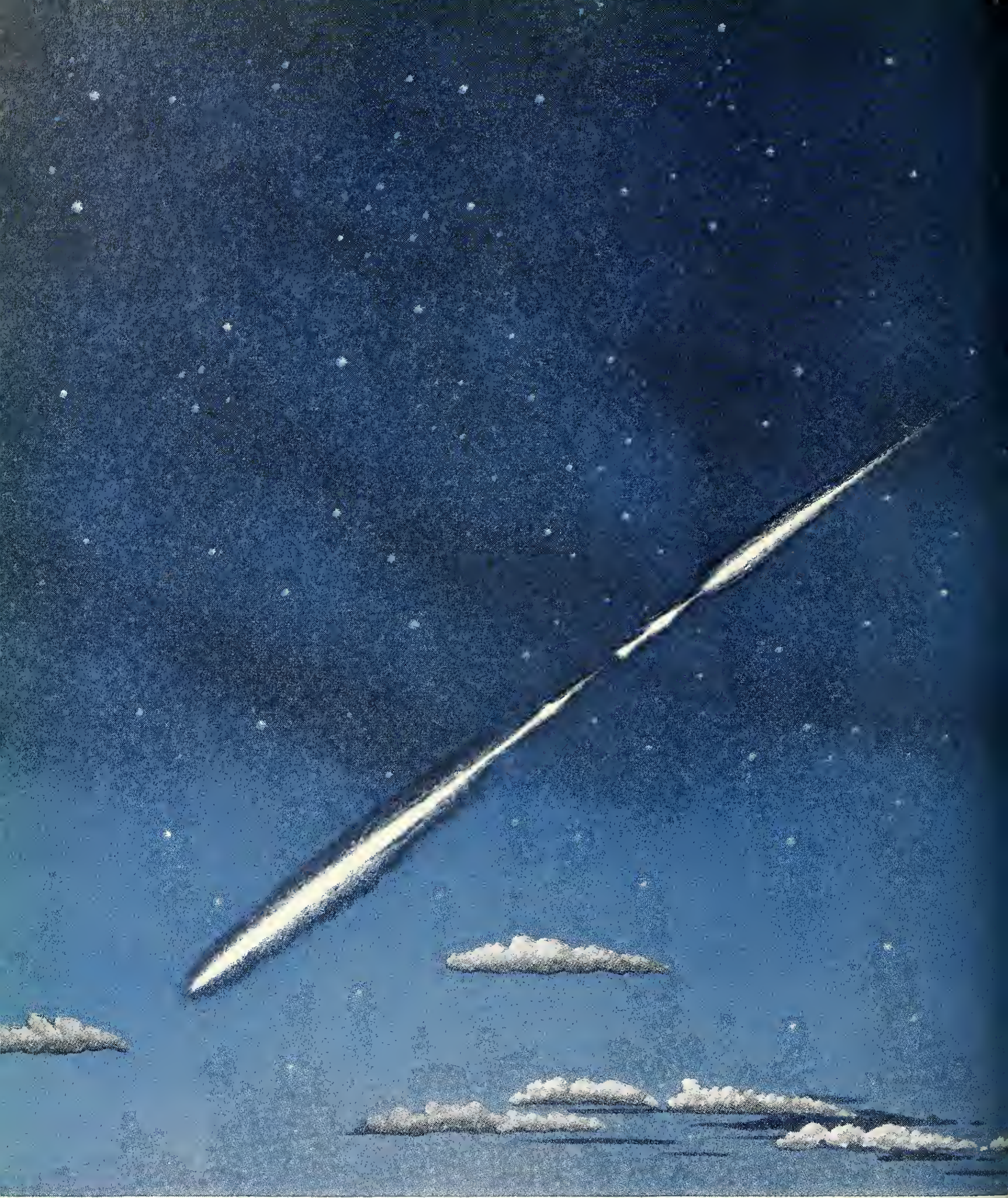

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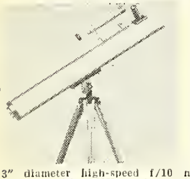

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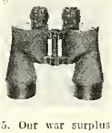

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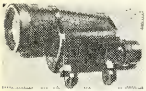

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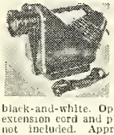

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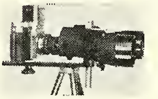

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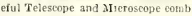

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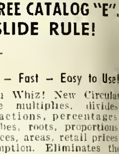

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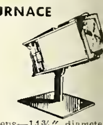

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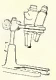

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the answer after studying the heels inside electric comput- es. He came upon a way to n's hand supply the 'power' els . . . instead of electricity! ne! He invented an adding esigned so that the gentlest es the wheels inside turn! complete turn . . . the first wheel automatically trips the next wheel . . . just like $200.00 electric machines! Nothing to remember. Nothing to do but press down the numbers to be added. Everything else automatic!

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THE FLIGHT OF BIRDS *Wesley E. Lanyon*
FOGHORN SOUNDS BENEATH THE SEA *William N. Tavolga*
A YEAR OF THE NAMIB *Henno Martin*
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DEPARTMENTS

REVIEWS *Richard G. Van Gelder*
LITTLE CLIMATES *E. Laurence Palmer*
SKY REPORTER *Simone Daro Gossner*
NATURE IN ROCK AND MINERAL *Paul Mason Tilden*

COVER: The anatomical detail presented on the March cover shows the disse
swim bladder of *Opsanus tau*, the Atlantic toadfish. Grasped in the dissect
forceps is the fine membrane that, when set in motion by the vibrating air
is contained within the balloon-like swim bladder, acts as a sort of druml
in producing this fish's peculiar grunts and boops. Why the toadfish makes
coastal waters resound with its noises is an open question and one that
engaged the attention of an AMERICAN MUSEUM research associate in ani
behavior, Dr. William Tavolga. For an account of his investigations, see p.

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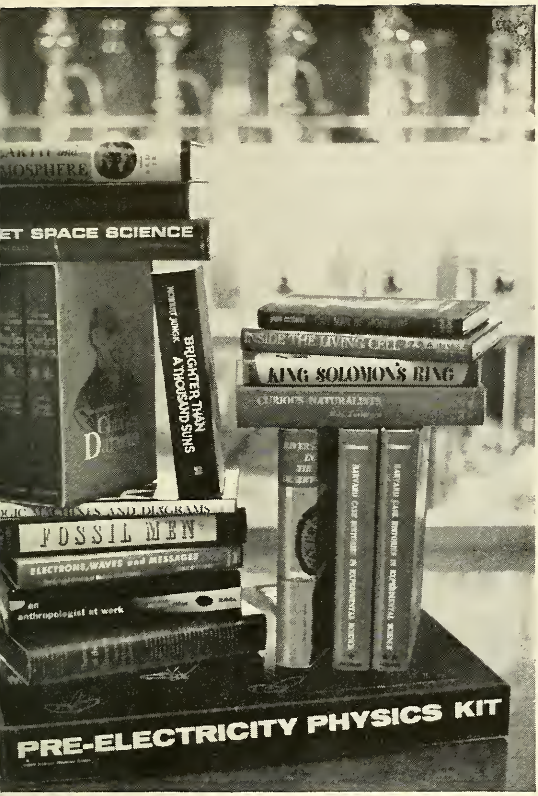
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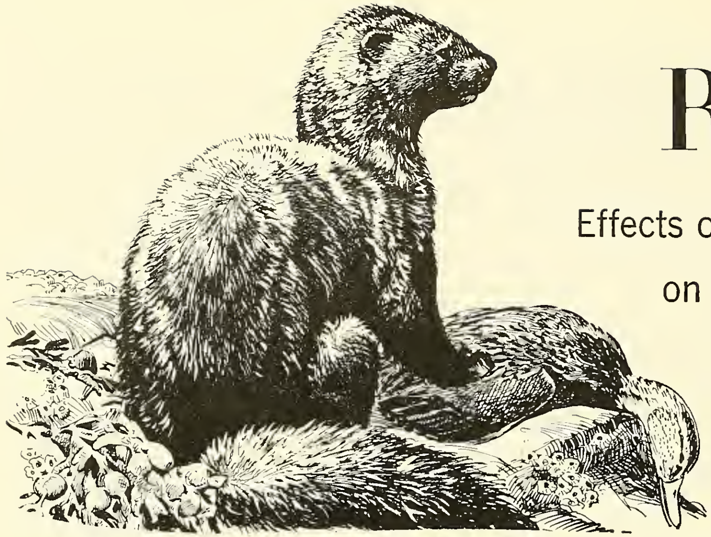


Extinct sea mink is seen in reconstruction drawn by Bob Hines.

Reviews

Effects of man's supremac
on the life around hi

Reviewed by
Richard G. Van Gelder

Wildlife in America, by Peter Matthiessen. *Viking, $10.00; 304 pp., illus.*

A Natural History of New York City, by John Kieran. *Houghton Mifflin, $5.75; 428 pp., illus.*

Should mankind succeed in exterminating itself, it will be the first time that a species has caused its own extinction with the awareness of what it is doing. Death on an individual level is something that every animal strives to avoid, but knowledge of the impending death of a species is something that only man has the system of communication and the awareness to predict. Extinction, of course, is a part of evolution, and there are many more kinds of extinct animals than living ones. This fact is readily understandable when one thinks of the many millions of years through which life has evolved and during which experimentation by nature—predation, cataclysm, disease, and climate—have taken their toll. The animals that exist today are the survivors of evolutionary changes, and man is one of them.

In both life and death every animal leaves its mark on Earth, but as individuals, few creatures exert much pressure on the environment. Certain species, however, because of their large size or huge numbers cause sufficient changes to the ecology of their habitats to be called "ecological dominants." In this regard, man is undoubtedly the dominant species on Earth today.

As an ecological dominant, man is altering environments on a world-wide scale. He cuts trees, plants crops, levels hills and mountains, builds houses and skyscrapers, drains swamps, irrigates deserts, pollutes rivers and air, and desalinates ocean water; he destroys viruses, bacteria, plants, and animals, and he raises livestock. Man alters his environment to suit his needs or whims.

Eventually, ecological dominants come into equilibrium with their environment, so that their populations become stabilized within the bounds of the natural resources of the area. Man, however, has become an ecological dominant on a world scale so recently that he has not yet come into the "natural balance" that will be necessary for his survival.

Man's accession to the role of a world-wide dominant has occurred only in the last three or four hundred years. At the middle of the seventeenth century the world population was about 445,000,000, and for the preceding thousands of years it had been increasing only slowly to this point. But then the population erupted, so that in some three hundred years it has increased five-fold and is increasing still. Just what caused this surge in numbers is not known, but it must include a multitude of factors, one of which is surely the advances in communication that not only permitted the exploitation of newly discovered lands, but also allowed the expansion of population in places distant from a source of food. Basically, of course, the increases have resulted from a better survival rate for man as he gradually learned to cope with the ecological factors that previously had held his numbers down.

The large-scale and rapid destruction of so many kinds of animals by man is part of this population explosion. The systematic extermination of certain animals must have started with primitive man's development of agriculture and consequent freedom from the dangers of nomadism involved in following game herds and fruiting seasons. The establishment of permanent homes permi
by the raising and storing of crops
the domestication of animals for f
was the beginning of man's ascent to
dominant position in the ecology of
earth. Because of the physical pro
tion afforded by villages, man's so
structure changed from the family gr
or groups to larger aggregations. C
munity co-operation, based on the r
tively large supply of manpower av
able, started the process of exterminat
of many animals.

The first animals to be attacked
tematically were probably the large
nivores, initially because of their inher
danger to man, and then because of th
depredations on man's livestock. In a
tion, the larger game animals in
vicinity of a village soon would be kil
off or driven away because of the
turbing presence of man. Although
control measures enacted by primi
villagers were important in altering
local ecological picture, they were s
ciently restricted and isolated geogra
ically to be of rather minor importa
in the over-all ecology of the earth.
an indication of the future was pres
and man continued urbanizing and
creasing in numbers until the populat
exploded in the seventeenth century.

The effect of this population gro
on wildlife is evident from the follow
figures on the extinction of mamm
given in Francis Harper's *Extinct*
Vanishing Mammals of the Old Wor
from the time of Christ until 18
thirty-three species and subspecies
came extinct; in the next one hund
years an equal number of kinds of ma
mals became extinct, and in the f
half of the twentieth century, forty m
kinds disappeared from the earth. In

hundred years, two-thirds of
of 106 listed by Harper have
erminated. Although specialists
alian taxonomy may feel that
s unduly long by reason of the
ce of certain classifications, the
ntal picture remains the same—
number of mammals to become
as been increasing in the past
dred years. The same is true of
ere eighty-three kinds have be-
tinct in the past two hundred
years and nineteen more are
extinct.

ot only the story of the extinc-
mammals, birds, reptiles, am-
and fish in North America that
atthiessen tells in *Wildlife in*
for he discusses the rare and
animals as well. Although
the information is available in
. Allen's *Extinct and Vanishing*
s of the Western Hemisphere
enway's *Extinct and Vanishing*
the World, Matthiessen has, for
time, provided a geographic,
and chronological account of
things that man has done to
es in North America. The pic-
he paints is an ugly one of
estruction, of waste, and of in-
le crimes in the name of sport
dience. Not only does he tell of
rect encounters with wildlife,
of innumerable actions of man that have indirectly but definitely affected the lives of our fauna.

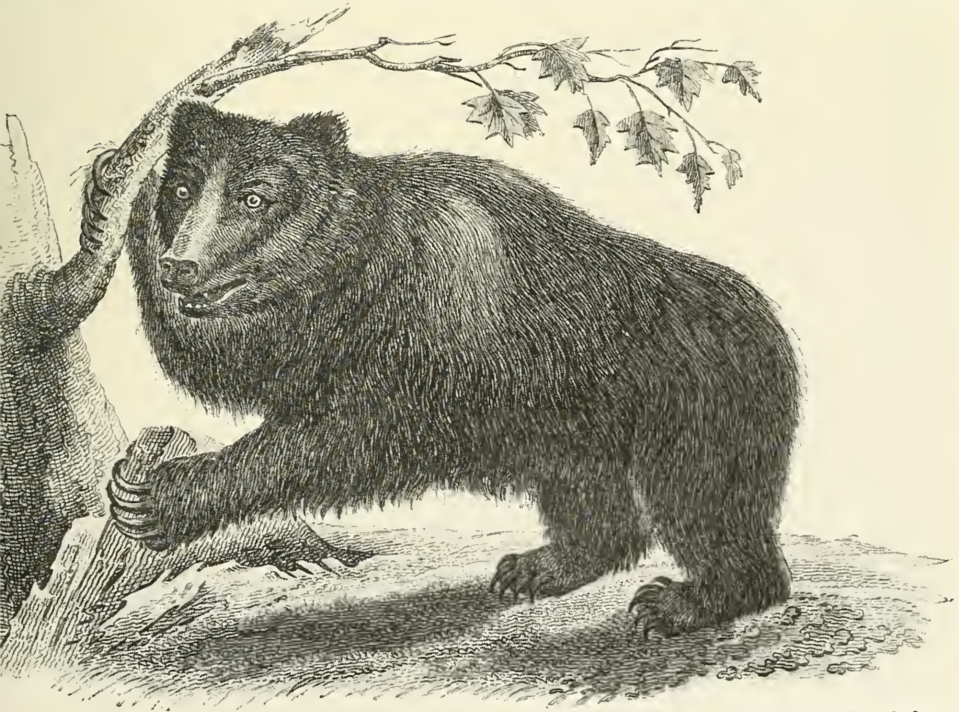
This month's lead review comes from the Chairman of the Department of Mammals at THE AMERICAN MUSEUM.

It is a shocking fact that effective legislation to control the mass destruction of American wildlife has been operative for only half a century. By the end of the nineteenth century, legislative acts were being passed that ultimately led to the protection of many kinds of animals, but for others it was too late. The long-eared kit fox, the Newfoundland wolf, Florida wolf, eastern mountain lion, Arizona wapiti, Badlands bighorn, and a number of local forms of grizzly, as well as the passenger pigeon, Eskimo curlew, and Carolina parakeet all disappeared after 1900, but they had been doomed much earlier.

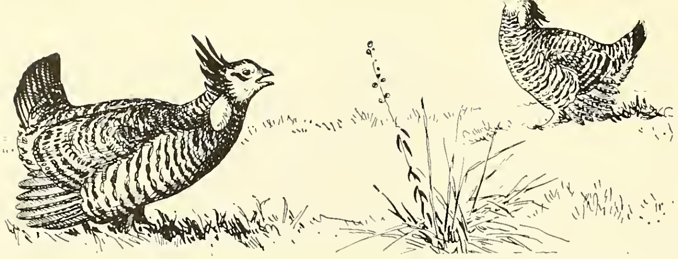
Starting with the outlying islands of North America and the extermination of the great auk, Matthiessen works his way across America by biological regions as they were first explored and later inhabited by Europeans. His documentation of the disappearance of some of the species that have been most diminished in numbers is sketchy, but certainly sufficient to whet one's appetite for the details. Lamentably, the bibliography omits many of the primary accounts (for example, Hornaday's *Extermination of the American Bison*) that the reader might wish to know of.

Wildlife in America covers a lot of time and territory in a readable and pleasant style. The author is at his best when he recreates the end of a species, as he has done in the opening chapter on the great auk. In it he has grasped the insensible, opportunistic ethos of the men who would destroy the animal, as well as the pathos that mankind should feel at causing the end forever of the product of millions of years of evolution. Least desirable are Matthiessen's unnecessary digressions to explain the finer points of subspeciation, taxonomy, and the differences between splitters and lumpers, and with a sophistication born of hindsight to criticize some of those on whose works he has elsewhere drawn so freely.

Perhaps a history requires no thesis, but one feels a lack of direction as the book progresses, and at the end the reader is offered nothing for the future. It might have been hoped that Matthiessen would use the knowledge gained in research for this book to offer a program or theme for the future of American wildlife, but such is not evident. Nevertheless, for the reader who wants a relatively complete picture of the effect of man on wildlife in North America in a well-written fashion *Wildlife in Amer-*



GRIZZLY BEAR was drawn by early American naturalist John Godman.



RARE Attwater's prairie chicken, *right*, and extinct heath hen.

ica is highly recommended. The book is attractively illustrated with line drawings by Bob Hines of most of the animals mentioned in the text, contains eight color plates and sixteen pages of photographs, and two appendices that summarize the rare, declining, and extinct vertebrates and a chronology of wildlife legislation, as well as a bibliography.

That many animals are able to persist despite man and his activities may not seem likely in the light of Matthiessen's book, but one has only to turn to John Kieran's *A Natural History of New York City* to discover an almost unbelievable array of animals and plants that, for the most part unobtrusively, inhabit one of the world's greatest urban areas.

Just as Matthiessen's book is more than a narrow compilation of extinct and vanishing animals, Kieran also has written a book of broad scope. In fifteen chapters, he has produced an old-style natural history book. Starting with the history of New York City and running through the geography and geology, he then covers almost every group of animals and plants that can readily be discerned with the naked eye (or perhaps with an assist from a hand lens)—from the single celled protozoa and algae to whales. As he rambles leisurely, but with direction, through fifty years of natural history in New York, Kieran takes the reader on a subway safari, and even the native New York biologist will be surprised to learn what is available in his home territory.

Kieran has written a book that might well be used as a field guide for New York naturalists, and indeed every urban biology teacher should be required to read it. *A Natural History of New York City* is essentially a biology textbook in non-technical language, which uses as examples the fauna and flora of a city. Kieran not only tells what is present, but he describes it, categorizes it, puts it in its place in nature and New York, and reminisces over it. And the total is a pleasant reflection of biology that even the most sophisticated urbanite will enjoy and from which he will learn much.

The book is decoratively illustrated with sketches by Henry Bugbee Kane; but while they are attractive, they are often of little help in the identification of species. One might also have hoped that Kieran would have included some references to literature specifically on New York biota rather than the eleven general guides or checklists that he cites.

These are two books about man and nature and two different aspects of their relations. If one takes the viewpoint that man is just another animal, then one only need sit back and observe. However, if man is the superbeing that he thinks himself, then he must utilize his abilities to learn his ecological position and to adjust his own life with the life of the flora and fauna around him to a state of equilibrium. At present, man is still unwilling to control his destiny; if and when he does so, he will have achieved a mature civilization. If he continues in his present direction, he may join the myriad of other extinct animals that could not adapt to the ecological situations. Peter Matthiessen has shown what man has done to vertebrates in North America and John Kieran has shown what animals in the presence of man can do with a minimum of encouragement. Both books are welcome additions to the literature of natural history.

SHORTER REVIEWS

FIFTY YEARS OF BOTANY. Golden Jubilee Volume of the Botanical Society of America. Edited by William Campbell Steere. *McGraw-Hill, $10.00; 638 pp., illus.*

IN 1956, the Botanical Society of America celebrated its fiftieth anniversary. In honor of this occasion, a number of outstanding authorities in various fields of botanical activity were invited to contribute papers "on the major advances and important developments in botany during the past fifty years, with emphasis on present trends and future problems and on the contribution of plant science to mankind and to his civilization." The forty papers of this volume result from the Society's invitation.

Throughout the jubilee volume, botanists themselves take a very critical view of contemporary botanical teaching and of the role of botanists in modern society. Botany courses fail to draw students, and many have been merged into general biology courses for reasons of economy. The causes for the lack of enthusiasm over botanical courses are manifold, but most of these authors agree that botany courses are oriented to the stu-
dent preparing for a profession in bota
and ignore the great majority of stude
who take only one botany course duri
their scholastic career. There is
much concentration on minutiae of str
ture and function, dissection and sket
ing, almost to the exclusion of
contact with the living plant in
greenhouse, garden, or field. Not onl
botany suffering from the students'
of interest, but the students themsel
are being deprived of information t
would enrich their lives, improve th
understanding of the environment,
perhaps make direct contributions
their professional advancement.

The most often repeated criticism
the social failing of the botanists is
inability or unwillingness to convey
knowledge to his non-professional nei
bors. Fortunately, several contribut
to this volume are free of these faili
Their papers vary considerably in s
and in the amount of professional jar
a few are marred by unfortunate t
graphical errors and relatively seri
editorial contradiction (for example
page 57, Leeuwenhoek is credited
inventing the microscope in the
seventeenth century, while on page
another author assigns its inventio
Janssen in 1590), but all are of g
interest and are well-worth read
Kenneth B. Raper, in "Microbes—M
Mighty Midgets," outlines progress
the study of microscopic plants, in t
utilization in industrial and nutriti
fields, and in the development of
biotics. "The Fight with Fungi,"
James G. Horsfall, is a fascinating
vey of the impact of plant diseases
human history, of the developmen
knowledge about the causes of disea
and of the research techniques and
trol measures currently in use. E
Stakman presents an engrossing stor
the battle against wheat rust. Ken
V. Thimann, in "Growth and Gr
Hormones in Plants," gives an intro
tion to the history of the discover
chemical growth-regulating substa
in plants and a survey of researc
their nature and actions. A. S. C
presents a summary of our knowled
chemical weed control, and W. H. H
points out the need for co-ordinatio
efforts to find new uses for product
the wild plants of the world in "
Plants for Man."

Four papers are of particular im
tance to the professional botanist,
are also of interest to others bec
they represent a public confession o
failings of botanists and a plea
change. Hiden T. Cox and Joh
Behnke, in a paper with the captiva
title "College Botany Could Come Al
critically analyze the current co
and orientation of college begin
botany courses and suggest revisio
the courses to meet the needs of

(Continued on pag

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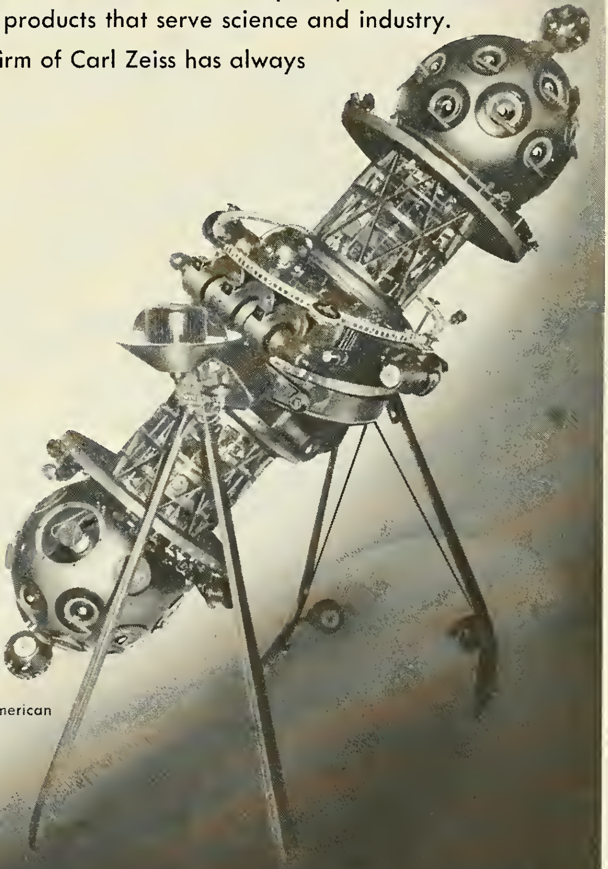

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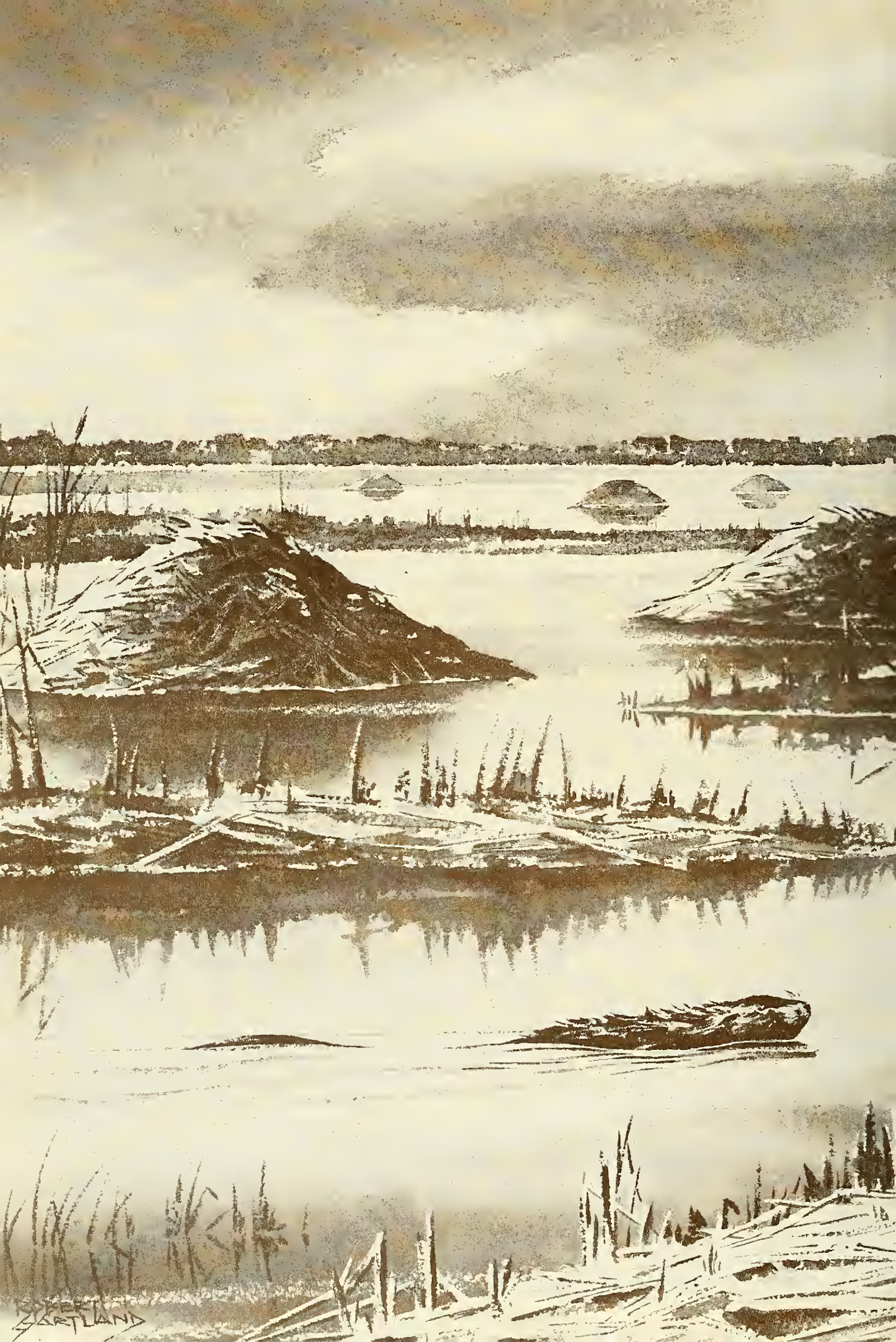
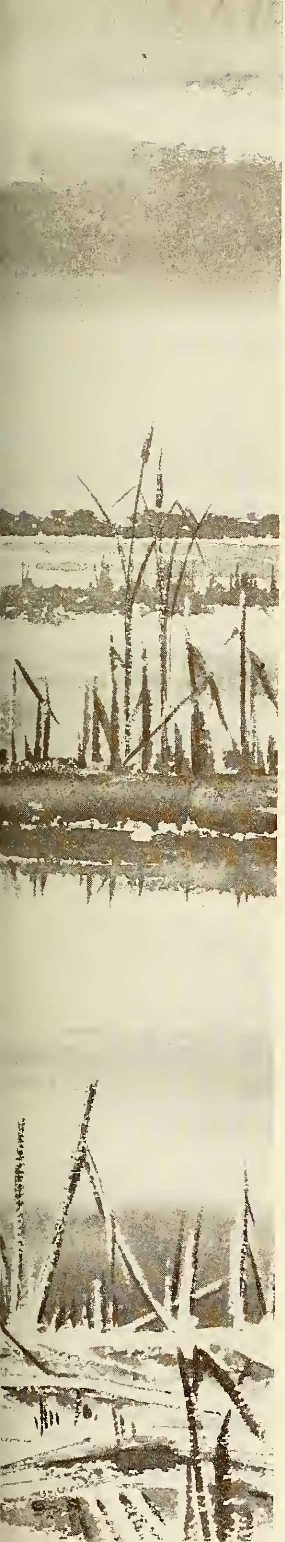
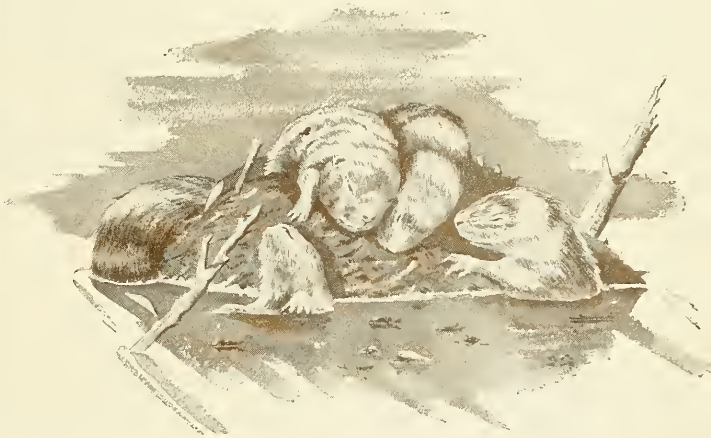






Lodges dot summer marsh, *left*, and muskrat inhabitants find living easy.

During floods, mothers may deposit young, living and dead, on dry litter.

Wetland Saga

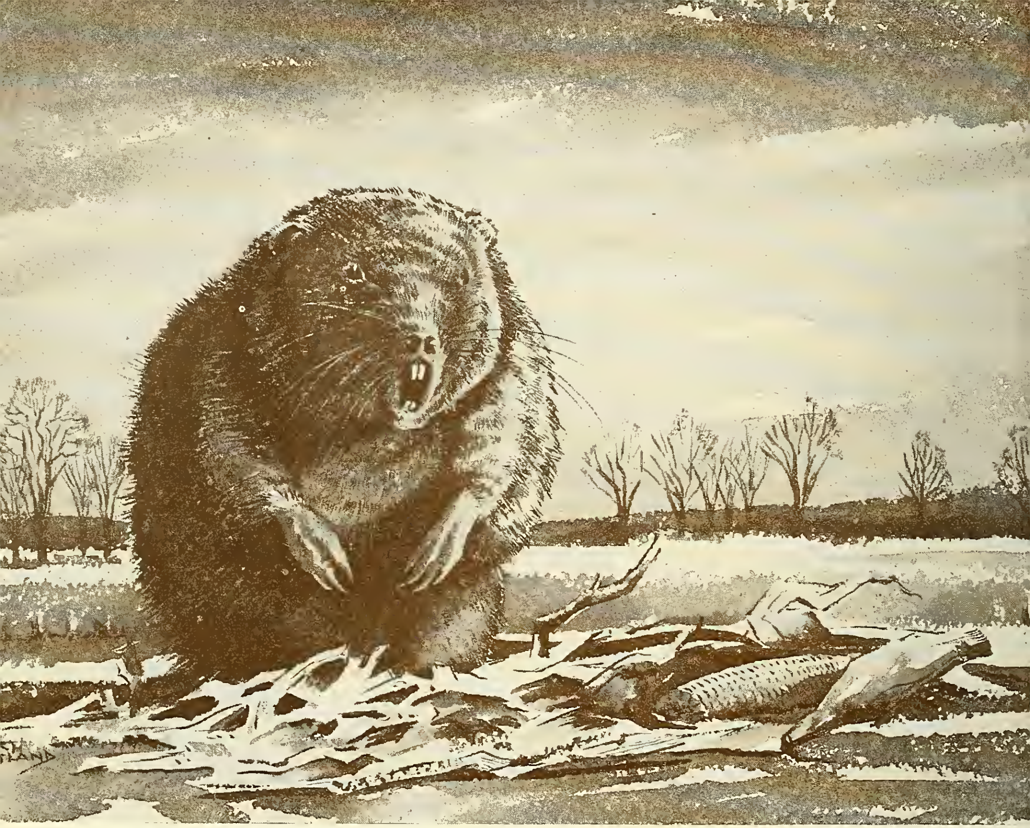
Flood, drought, freezing, and predation are the risks for a marsh muskrat population

By Paul L. Errington

To the muskrat, that almost typical member of a North American marsh community, each day is something to live for in itself, whatever may be the season of the year. But since spring is the season we usually associate with biological beginnings, we shall begin here with spring to portray the seasonal fortunes of this wetland animal.

By the calendar, spring sometimes comes when the snow is as deep, the ice as thick and as hard, and the temperature as low as in the severest part of winter. But the tracks of the wide-ranging minks during their late-winter breeding season are laid down in powdery snow or in slush, on wet sand or on frozen mud, or on dry soil. Restless skunks emerge from hibernation long before the weather could tell them to, and great horned owls incubate and brood their young right on through late February and March and April blizzards. As sexual awakening progresses in the muskrat populations, living out of sight of human eyes in their lodges and burrow systems, more and more animals come out and sit on the ice on mild days, until, with the ice gone, the main dispersal away from crowded wintering quarters to easier living sites begins.

Dispersing muskrats travel along marsh and lake edges, along streams and up gullies. They may act like cautious and adaptive explorers, who know what they are doing. Or they may get started in footloose, hazardous wandering and show up on city streets or in farmyards or in any number of out-of-the-way places—if they live long enough. They may travel far or they may not. Living uncertainly or living securely, they hide or fight, doing their best to stay alive—somehow. They face flood, drought, predation, and disease, but between these various crises they may live well. They are not creatures to worry.



Spring dispersal of crowded muskrat colonies may send the animals far afield. They follow lake and stream edges searching for food, and may wander into village stre
into farmyards, where they forage for whatever is avai

Late spring floods may cause severe losses to the marsh muskrat population. As the water rises in their burrows, they stay as long as they can and then open up the tops and enlarge the chambers just below the surface of the ground. As the water nears the chamber top or covers the ground, they must come out, to build nests anchored in whatever vegetation there is along the banks or out in the marsh, or to sit in the scrub willows, or to lie quietly, trying somehow to remain in the neighborhood. If there are helpless young in the burrows, the mother may deposit them, one by one, all or only part of the litter, in a drier place outside. Young of swimming size may lie in a pile in the water, in a hole or in a nest, the lower ones withdrawing to climb on the others, until some become too weak to withdraw any more, and their bodies lie, a platform of dead young flesh supporting still-living young flesh. At high flood, all the muskrats of the low bank islands may be gone, the old and the young and their nests and sitting places. Dead and living bodies may float away toward a lake, along flowing channels or off somewhere across the marsh, over the channels and banks and washed-down vegetation.

As spring grades off into summer, nothing much may happen to the muskrats, if they do not become overcrowded and the water levels are favorable to them. The midges hum, new shoots of reed and cattail appear above the water, water lilies float their new pads and flowers, masses of arrowheads take form, and, among the lodges, newly weaned muskrats swim, sit, feed, and dress themselves as if they amounted to something.

Late summer on a north central marsh is ordinarily a season of dry, hot weather. Some degree of drought is normal at this time of year over vast continental regions. It is with extreme drought that the big
changes occur. The last inch o
of water on top of the marsh mu
seethe with movements—gills, m
backs and tails. A little more exp
and motion ceases over the s
mud. Some creatures go beneath,
become part of a gelatinous film,
persist as shells or bony head
tails. Here is the down of a duc
or the woolly fur spread out fro
bones of a young muskrat, or pe
a freshly dead young muskrat
belly slashed by an older on
something with the shrinking s
death still moves as carrion b
work beneath.

Muskrat movements can be c
by too much, as well as too
water, as when a series of wet
may be accompanied by loss o
emergent vegetation of marshes.
a marsh, in one season, turns
an open-water lake, the evicted m
dwellers that cannot fly away
crowd the shores and adjacent
Muskrats, being among the su

such natural cataclysms, are
ed upon by the usual hunters of
e zones. The vulnerable muskrats,
e they last, live in cavities under
roots, in badger and woodchuck
, in tile openings and culverts,
r piles of junk and in nests fash-
l out of drift. They eat what they
close by and raid the corn and
s and small grain of cultivated
. They appear in grain shocks
farmyards, and they leave their
ins wherever they go until their
ving numbers are more in bal-
with their possibilities for living.

ESERT marshes of the West afford
great contrasts in life and life-
ess and, sometimes, in life and
. Along the east side of Great
Lake, muskrats that live in the
river and dike banks, and out
e bulrush patches, disperse from
hoicer environments in response
pulation pressures. Occasionally,
of them may find a fresh-water
g in which it can stay alive in
an unpromising place as an island
e Lake, surrounded by miles of
and desert.

e usual hunters of the shore zones
wland marshes of course include
ninks, and virtually any discus-
of North American muskrats is
to get round to minks—water
els with which muskrats have had
experience. The mink trails re-
the day-by-day drama of the
h edge. Either in the trails or at
penings of dens—such as holes
e upper parts of old muskrat
ows—mink "signs" tell of a staple
of crayfishes and frogs, or of
r beetles or dragonflies or black-
s or young coots. The mink trails
ometimes littered with clam shells
e the marsh is lakelike, or with
and prey when the minks have
ss to an inviting source of mice,
nd squirrels, grasshoppers, or
birds. On duck marshes, there
be duck bodies of every age on
nink trails or pulled into the den
s; on muskrat marshes, muskrats
among the conspicuous victims.

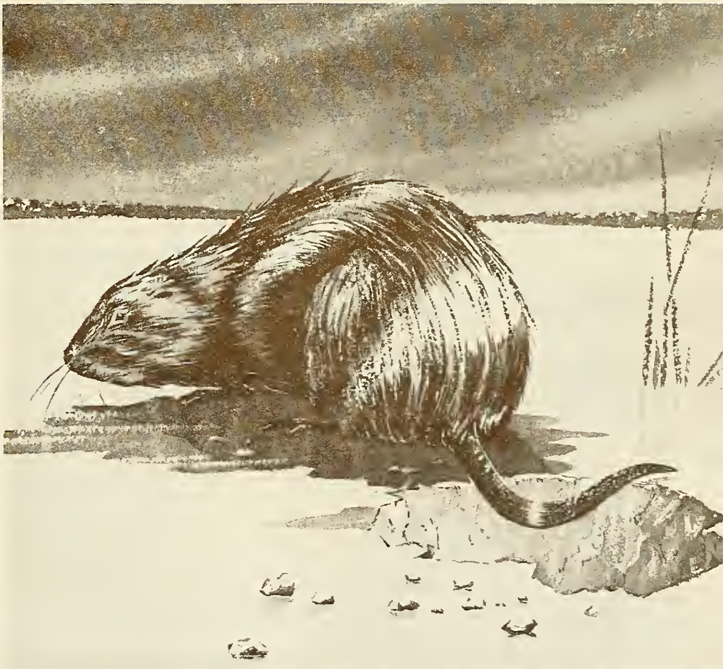
ink predation upon muskrats has
studied with particular thorough-
on Iowa marshes and proves to
ainly a matter of the minks utiliz-
part of the biological wastage of
krat populations. Up to midsummer. nearly all of the muskrats preyed upon by minks in the Iowa areas are the strife-battered excess males that are forced to wander off and live in risky places because of the intolerance of their better-situated fellow muskrats. In mid- and later summer, most of the mink victims are either surplus young, similarly forced into the dangerous shore zones to keep out of the way of their intolerant elders, or animals placed at overwhelming disadvantage through storm or drought emergencies. Mink victims, therefore, are not just any individual muskrats that minks care to prey upon, but rather those that have fallen into special classes of vulnerability.

Dr. Errington's book, *Of Men and Marshes*, was recently published by The Macmillan Company and received instant acclaim. The marsh muskrat saga is reprinted here by permission.

FROSTS of the Indian summer nights leave thicker and thicker ice on the ponds in the mornings. In shaded, quiet places, the ice may not melt all day. Where a muskrat swims, there may be a swirl of bubbles and pieces of broken ice film, or the animal travels submerged, breaking the ice film only where it surfaces. One evening, icy needles form a crystalline lacework on the lakeside rocks, the water's edge is still and films over, and the lake, also, except where the ducks sit. During the night, the new ice film thickens, cracking now and then, with water oozing from the cracks to freeze in turn. Muskrats sit beside the open holes. New lodges and feed houses appear over the marshes. Faint, muddy prints of both muskrats and minks mark the new ice. Lakeshore ice, in particular, may have a little blood, some bits of vegetation, fish scales, or skin about the rocks and openings where the minks and muskrats feed.

EARLY winter may bring no great problems for marsh animals adapted to live beneath the ice. The outside temperatures may vary from forty above zero to forty below without making much difference to the life in the water—as long as the essentials for living remain at hand.

With the continued sinking of the frost line, however, the seeming isolation from winter's problems may be transformed into a series of patent emergencies. In the course of a killing



TER FREEZE may force a muskrat to
upward through a foot of solid ice.

freezeout, the last places on a marsh where fishes keep alive include the plunge holes and channels of muskrat burrows and lodges. The water there may be packed with bullheads; almost all other marsh fishes die before this stage. The bullheads gulp air, trying to live, whether the oxygen is all gone from the water or not, whether the water reeks with hydrogen sulfide or not. A few die, or many may, and the living wriggle among masses of floating or partly submerged dead.

The muskrats may or may not feed upon fish, depending principally on whether they have access to an abundance of choice plant foods, to rootstocks or tubers of cattails, bulrushes, reeds, or duck potatoes. When the better plant foods are in short supply, the muskrats may feed upon the fishes almost to the extent that the minks do, either upon their own victims or upon those dragged out and left by the minks. The stomachs of nearly half of one sizable lot of midwinter muskrats from a northern Iowa marsh contained bullhead flesh.

The muskrats, not being as dependent upon the water as the fishes, have more leeway in meeting freezeout crises, but they, too, can winter-kill. As a rule, those living in a food-rich environment with little water get along better than those in food-poor environments with more water. In the shallows that are grown to cattails and bulrushes, the muskrats can still dig out nutritious underparts, even though considerable freezing of the bottom muck occurs.

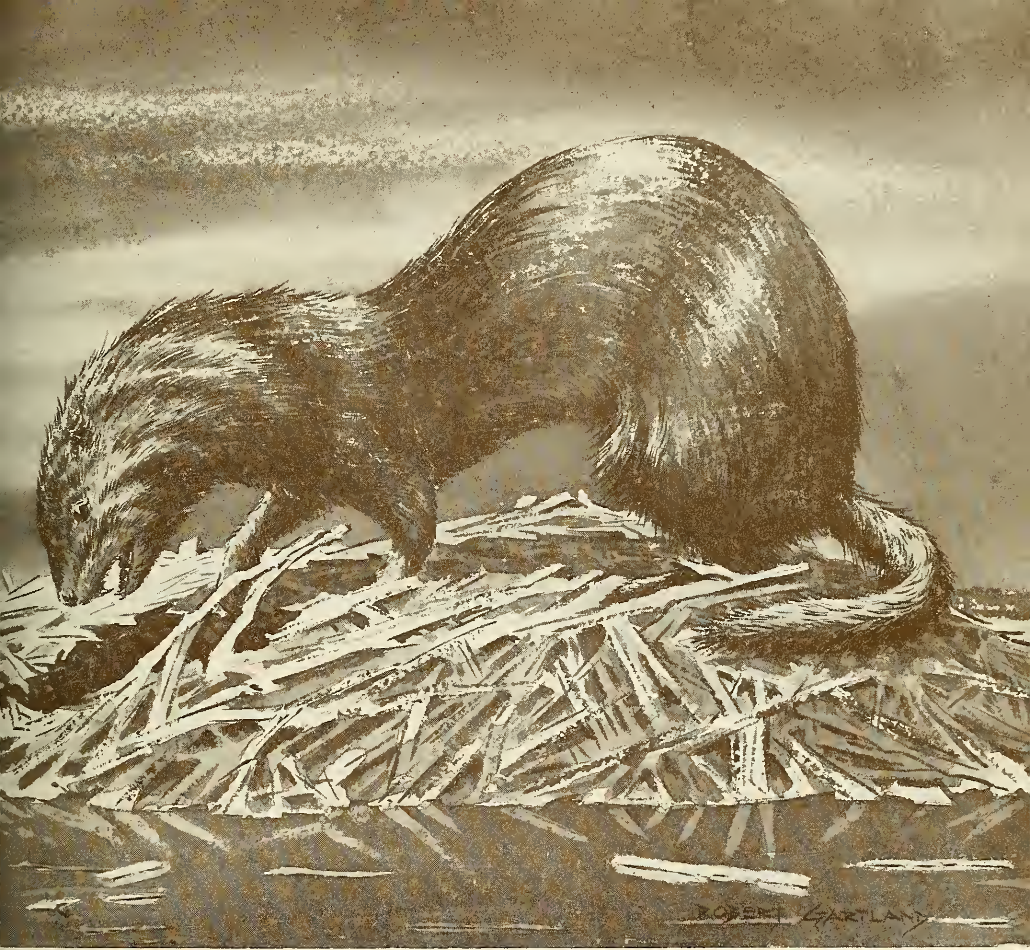
If the muskrats are forced to come out on the surface to feed in cold weather, some of them may still find something edible in the exposed plant crowns and rootstocks. They gnaw the favored parts right down into the ice and may almost stand on their heads, hindquarters braced above, as they tug and twist. They eat the river bulrush rootstocks sticking here and there from the outside of a lodge. When the entire food supply of the muskrats becomes encased in ice—as is often true where nothing but coontail and other submerged water plants occur in a foot or two of water, and all of this freezes to the bottom—their situation becomes one of deadly crisis almost in a matter of hours. They cut out through the sides of lodges to travel over the ice, going from one frozen lodge to another. They fight with and eat upon the bodies of their fellow muskrats or leave the marsh to wander over the countryside—tails, eyes, and feet freezing, always vulnerable to whatever predators prey upon muskrats that are trying to live at a hopeless disadvantage.

Here is a beaten group trying to weather a cold snap. They huddle, a half-dozen of them, in the eaten-out and reworked shell of a small lodge. Some openings to the outside are plugged with mud, fragments of water lily rootstocks, and miscellaneous debris—even with the frozen bodies of bullheads. Other openings are partly plugged; others are not plugged at all, and inside the muskrats sit—with upper parts frosting and lower parts wet. The inside ice-glaze has bullhead bodies in it but the muskrats are no longer eating bullheads. They are no longer doing anything except sitting or rearranging themselves. A wet tail tip sticks out of an opening and freezes to the ice outside. I have stroked the backs of such animals with a hatchet handle, and they just turned to look at me, without otherwise moving.

Next morning, the whole top of the lodge shell is open, empty of muskrats, and powdered by a trace of snow. A mink-killed muskrat lies smeared with blood on the ice, and a drag trail represents another victim. A third muskrat lies on the ice without a wound on it but with lungs congested from pneumonia. The trail of a live muskrat can barely be distinguished: after tracking around the wreckage of the lodge, the animal headed for shore, where it worked the rushy and weedy fringes before crawling under a boat. The muskrat tail tip is still frozen to the ice beside the lodge, but the rest of the animal is gone. Fox tracks center about this spot, and they lead off in a straight line toward shore. A crow alights by the mink-killed muskrat; after a little pecking, it walks over to feed on a big bullhead that somehow got on the ice away from the lodge. The mink returns to its remaining victim of the night, but the blood-saturated underfur is now frozen too solidly to the ice for the mink to wrench it free. The mink finally drags away the muskrat with the pneumonic lungs, following the same drag trail it had made earlier.

There are different degrees of security among wintering muskrat populations of glacial marshes, even where practically all individuals are able to

survive. Some have to do little e
sit, sleep, swim, feed, and sh
minimum of wariness toward the
ill-disposed of their fellow mus
and their racial enemies, the intr
minks. Others have to work har
their lives, as the ice thickens an
water recedes under the ice. Som
in dry passageways and run alon
trails between nests and feeding
Thaws cause the flimsier structu
collapse, or the ice or snow
about the pushed-up plugs of ve
tion, mud, stones, and sticks ove
burrows; and then the occupants
more problems of repairs. Plug
of openings may go to extreme
when a muskrat continues to pus
vegetation through a small hole t
cold outside, and, with each new



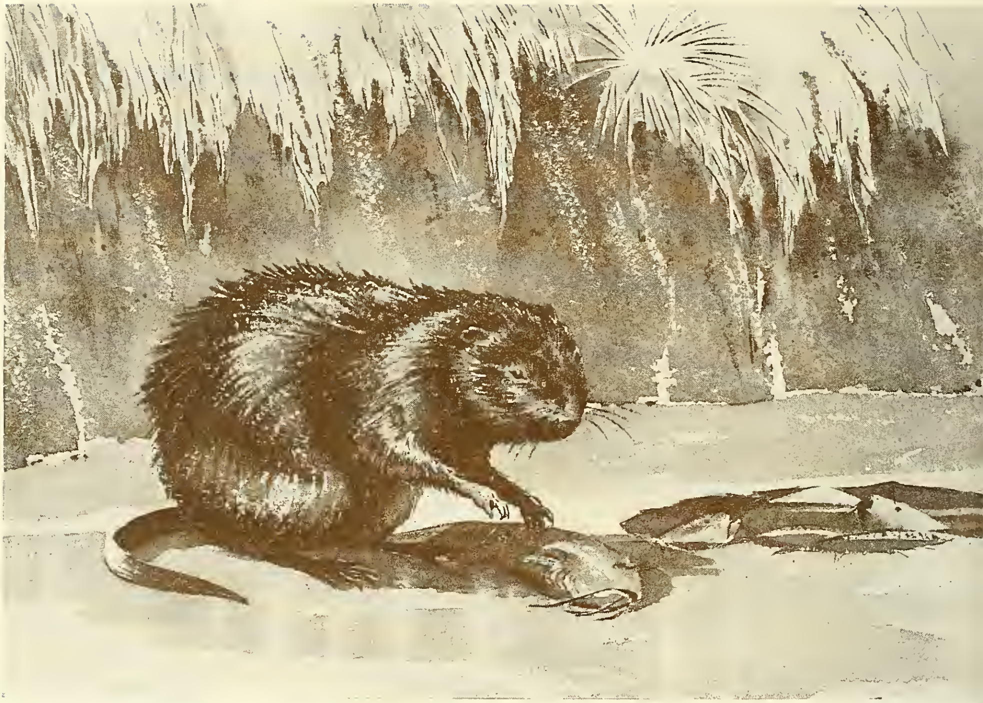
ACEOUS MINK, a constant danger to muskrats during
asons of the year, probably helps control biological wastage by attacking the starving, the roaming, the old, or the ill. Here, a mink burrows through top of flooded lodge.

n of vegetation protrudes farther
ie outside until it topples over
its own weight.

utting through ice, the muskrats
e adept if they work from be-
and they may work well at this
ater. They may gnaw upward
gh the ice in the middle of a
, and then heap up the vegetation
new lodge around the new hole.
l happened to be walking across
are ice of a marsh center when a
rat cut through ahead of me. It
l its wet body out, and there it
mid ice splinters beside a hole
ig down through a foot or so of
muskrat, working from below,
similarly gnaw the ice covering
lunge hole of a solidly frozen,
abandoned lodge and rehabilitate the lodge in a few hours.

A heavy thaw imposes its own problems upon a muskrat population that got along well in the labyrinths of layered ice and subsurface channels left by receding water during cold weather. The pouring of water from above does not necessarily endanger muskrats through drowning, for only under exceptional conditions are north central muskrats unable to reach air; but they may need to do some quick adjusting when forced out on the surface of land or ice or into the upper parts of previously unmaintained lodges and burrow systems. At such times, many of the animals are briefly vulnerable to minks and other predators—or to other muskrats if the emergency forces more intimacy than muskrats are disposed to tolerate, particularly as the spring breeding season approaches. If a cold snap follows the thaw while the muskrats are still in process of adjusting to the flood waters, their troubles are compounded. The luckier of the unlucky ones get by with only frozen tails.

THE minks are the specialists in seeking out and exploiting dead creatures. They are adept at detecting the scent of the dead as it penetrates to the outside from snowdrift or muskrat lodge or burrow. They are also sufficiently good diggers to break through many frozen surfaces and eat the accessible flesh of coots, ducks, and muskrats partly imbedded in ice.



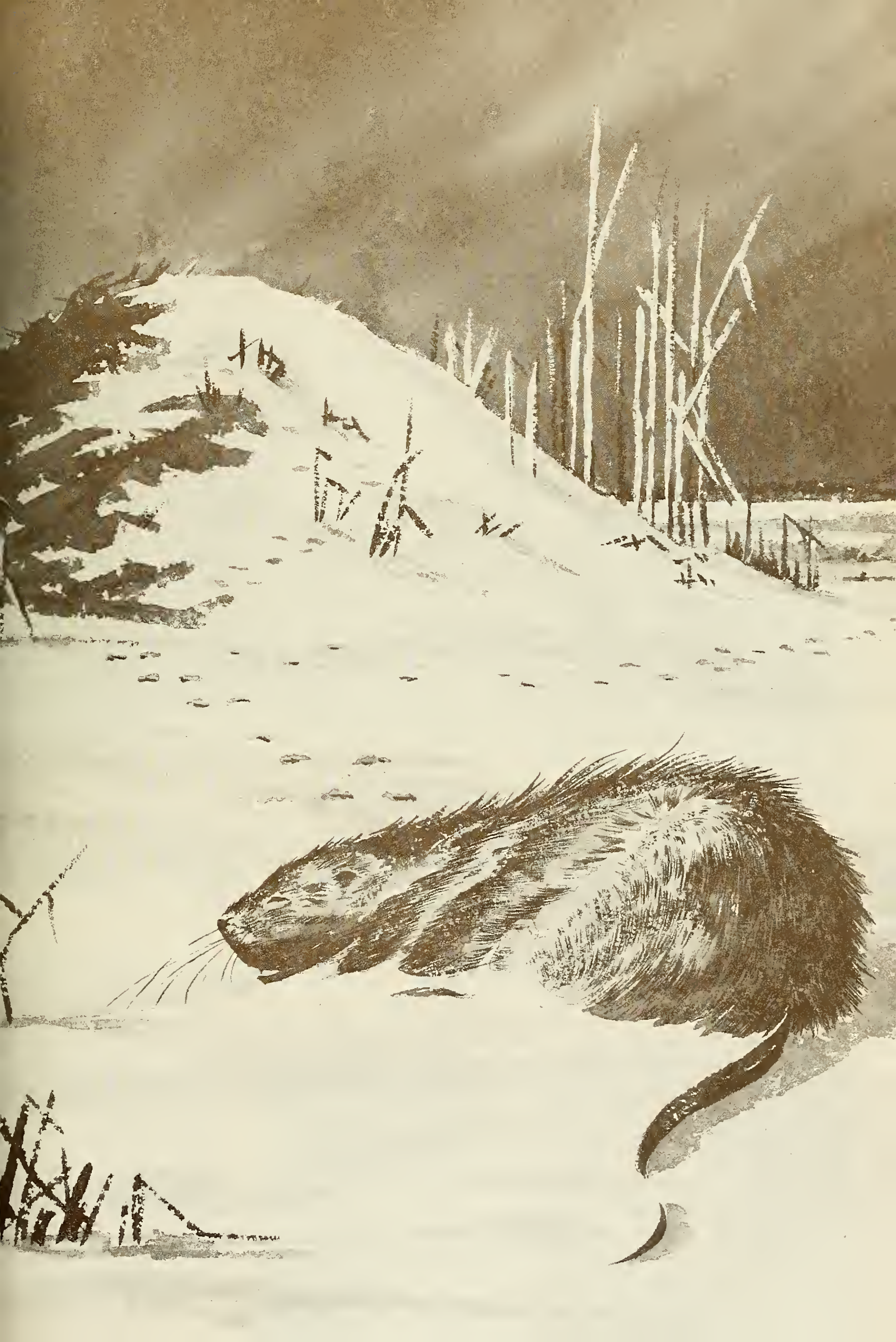
Dying bullheads pack themselves into an open plunge hole during a freezeout, *above*, and furnish food for muskrats.

**Food supply exhausted, feet, eyes, and tail frozen,
muskrat awaits its death by exposure, mink, fox, dog, or**

That the north central marshes really belong to the minks during the winter months is manifested in many ways. Minks may prey upon parts of muskrat populations that become vulnerable with the descent of the frost line. The "sign" shows where a muskrat ventured from an opening in the side of a frozen lodge, to make futile explorations about other frozen lodges. After tracking up new snow with its walking, digging, and gnawing, it began its return trip. Then the walking trail changed to a bounding trail that was joined by the trail of a big mink. The two animals rolled as the mink seized the muskrat by neck or shoulder, grappled with forelegs, and kicked and clawed with hind feet. On the snow is blood and a little fur. A dragging trail leads away across the open spaces, through the cattails and bulrushes and reeds, through marginal weed patches, between and over snowdrifts. Partly blown away in the wind, partly drifted over, the trail leads past one open lodge after another, then into a hole, several hundred yards from the site of the killing. A slightly older drag trail, likewise ending at the hole, backtracks to a place where mink and muskrat wrestled over the snow outside of another lodge. A couple of still older drag trails (but still datable to the same day or to the night before) also lead to the same mink's cache of earlier muskrat victims.

Within a week or so after the onset of a deadly freezeout, the muskrat population of a marsh may be classed as either the dead or the safe—safe, that is, until the frost line reaches another stage or until something else goes wrong for them.

One type of mink predation that can be conspicuous even at times of favorable wintering conditions for the muskrats is centered upon certain individual muskrats that show restlessness with the approach of the spring breeding season. The relatively few individuals of the well-situated population that start coming out on the ice during early winter or midwinter thaws, and persist in doing so for any reason, have limited life expectancies, whether their predatory enemies be minks, foxes, dogs, coyotes, or
of prey. These unhappy or restle
dividuals vary from full-fleshed
mals of either sex at their pea
physical prowess to the thin
chewed-up social misfits of eithe
that almost every muskrat popul
has. They include the senile o
mere "kits," the last-born your
the last breeding season. They in
trap cripples, the sick, or membe
the usual surplus of males. They
not fall in any handy classificatio
cept that they are muskrats l
dangerously while most of the
muskrats are living securely. V
these individuals are sooner or
killed off by the opportunistic p
tors that can do it, or die from
wounds inflicted by other muskra
are otherwise eliminated, the m
rats of a marsh may again be cl
as the dead and the safe—and
period of safety for the safe part
muskrat population may extenc
past the spring breakup and the
persal from wintering to bree
quarters, the presence of mus
hungry, enemy minks notwithstan

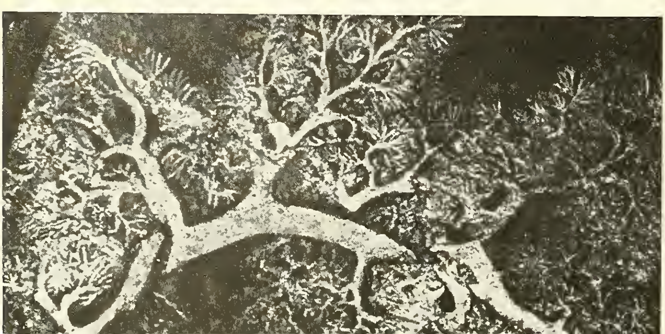


RED ALGAE lie exposed at low tide along the seashore in Japan, where these plants have an important place both as food and in industry (they provide a source of gelat
agar-agar, used by bacteriologists in culture media)

Complex Primitives

Red algae are among the lowest plant forms; but their intric

FOSSIL IMPRESSION from an extinct red alga, *Waputikia,* is shown below. Type flourished in the seas of the Cambrian period four hundred million years ago.



By I. MACKENZIE LAMB

SOME TIME VERY EARLY in th
tory of life on this planet, p
tive plants evolved that possesse
green pigment-complex we call c
phyll. By means of this, they
able to trap the energy radiated
sun and use this energy to bui
needed foodstuffs from the simp
organic elements in the air and
These first green plants were the
a group that has persisted throug
many millions of years between
time and the present—almost th

are classed primarily according to pigmentation and nto three main groups: green, brown, and red. Red and brown algae, like the green, contain chlorophyll, but it is masked by other pigments that give these types their color.

The Red Alga Group

ode of reproduction indicates a long evolutionary development

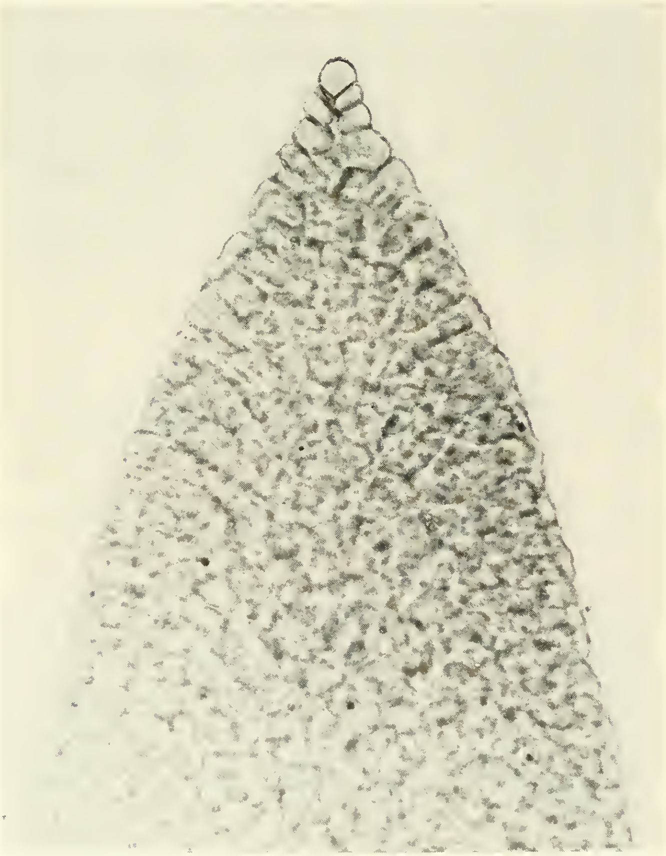
historical span of living matter.
e cannot tell for certain just what
first, ancestral algae were like,
hey had no hard parts to resist
y and leave their imprints. like
h masks, in the rocks. Not until a
iderably later period did some of
develop inorganic shells (or exo-
etons) of lime or silica to be pre-
ed as fossils and thus, aeons later,
he tale of their structure and mode
ving. Like all forms of primitive
however. these ancestral algae

Present-day red alga, *Heterosiphonia*, resembles fossil *Waputikia*, suggesting a close relationship between two plants despite wide time-gap separating them.

were assuredly of a simple and barely differentiated structure—probably one-celled organisms floating on or near the surface in the warm, sunlit waters of those times' ancient seas.

But evolution proceeds from the simple toward the more complex, incessantly tending toward a closer integration with the environment and a better utilization of available resources. Thus, among the algae, these primitive, one-celled plants developed specialized offshoots and lineages of more refined, efficient, and complex structure. Chief among these forms of specialization was what we call "colonial organization," in which a number of individuals pool their resources by remaining permanently attached to each other, with an increasing tendency toward the modification of certain cells to perform particular functions for the benefit of the composite whole—functions, for instance, of protection, of assimilating foodstuffs, of locomotion, and of reproduction.

The extent to which this evolutionary specialization proceeded among the algae is obvious when we consider such an example as the seaweed brown kelp, in which the vegetative body (or thallus) reaches a length of several yards and is differentiated first into a basal, rootlike attachment that holds the plant fast, then a stalk, and finally a broad, characteristically leaflike frond for the assimilation of food. All three structures closely mimic the root, stem, and leaf structure of higher plants, and arose—by the process known as convergent evolution—in response to comparable biological and environmental factors.



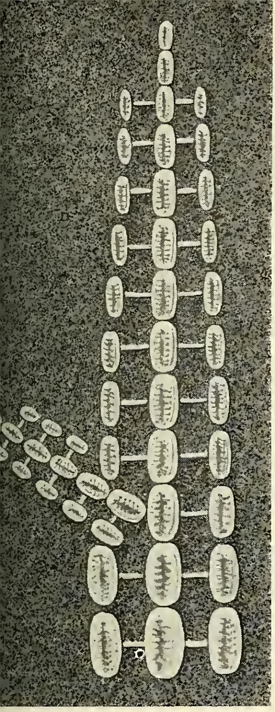
Growing point visible at alga's tip is actually, in many red algae types, the end of single filament extending whole length of plant and forming its core.

Filament of cells cemented to
is basic form of red algae. On

It is obvious that the algae,
early period in the history o
evolution, before any of them h
tained any great degree of spec
tion, came to a parting of the
The original pigment common t
all, known as Chlorophyll A, h
blended, in some offshoots, with
types of chlorophyll possessing
ent chemical compositions an
became masked to a greater or
extent by other, accessory pig
the carotenes and xanthophylls.
changes were to influence prof
both the appearance and the
tional biology of the newly
stocks among the algae.

Indeed, we now know that p
tation is a very fundamental ch
in the algae as a whole, and n
classification of this group of p
as first systematically expound
the Irish botanist Harvey, s
over a century ago—rests prima
this single feature.

The seaweeds of our rocky
fall into three broad natural g
all based on qualities of pigmen
the green algae (Chlorophycea
brown algae (Phaeophyceae), a
red algae (Rhodophyceae).



al pattern as seen in living plant;
ht, "exploded" diagrammatic view.

, microscopic and therefore usu-
unnoticed, are also present, such
liatoms, golden algae (Chry-
yceae), and blue-green algae
nophyceae or Myxophyceae).

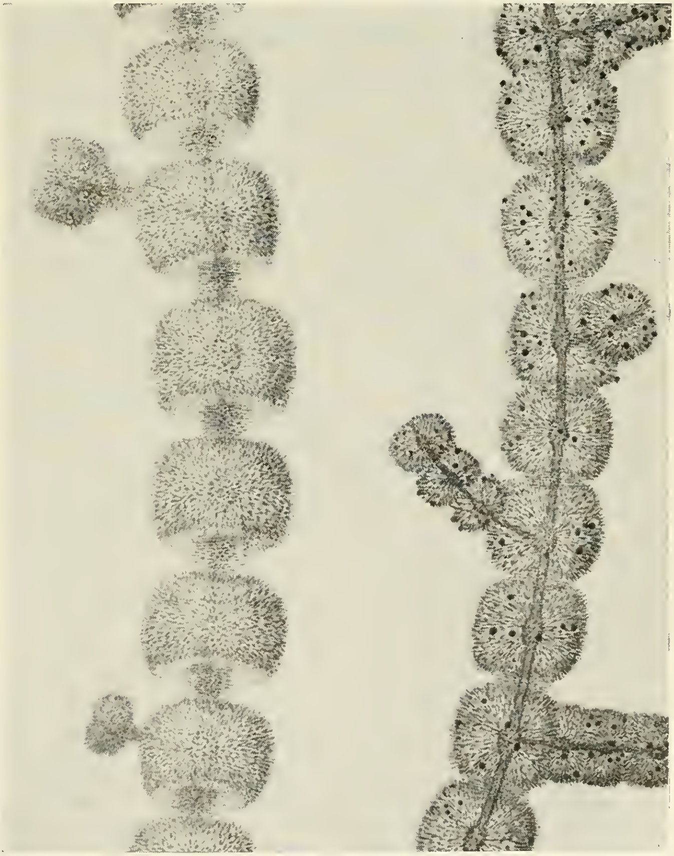
F the three major groups of algae,
however—the greens, browns,
eds—only the greens, which carry
rophyll A and Chlorophyll B,
to have evolved into higher
s, and only they can claim to be
stors of the higher, spore-bearing
seed-bearing land plants, the
of whose leaves is made up of
same chemical compounds. The
n algae and the red algae repre-
evolutionary blind alleys. Both,
true, attain very considerable
lexity as algae, but both are with-
ssue among the higher plants.
the brown algae, the pigments
Chlorophyll A and Chlorophyll C,
ed by xanthophylls—yellow-
n pigments that give these plants
characteristic olive or brown
. The red algae have, in addition
hlorophyll A and Chlorophyll D,
in water-soluble pigments called
obilins—mainly the red pigment,
n as phycoerythrin. It is this red
group of algae that forms our subject.

Very few one-celled red algae exist —by far the greater number have a more complex structure, consisting of cells joined together to form threads or filaments. Indeed, this filamentous structure is the basic form in almost the whole group, an underlying structural theme upon which many, often highly complex, variations are played. In the more advanced forms, belonging to the subgroup known as Florideae, curious thickenings (called pit connections) exist in the walls between adjacent cells. These may form both "primary" connections (between cells of the same filament) and "secondary" ones (between the cells of one filament and those of its neighbor).

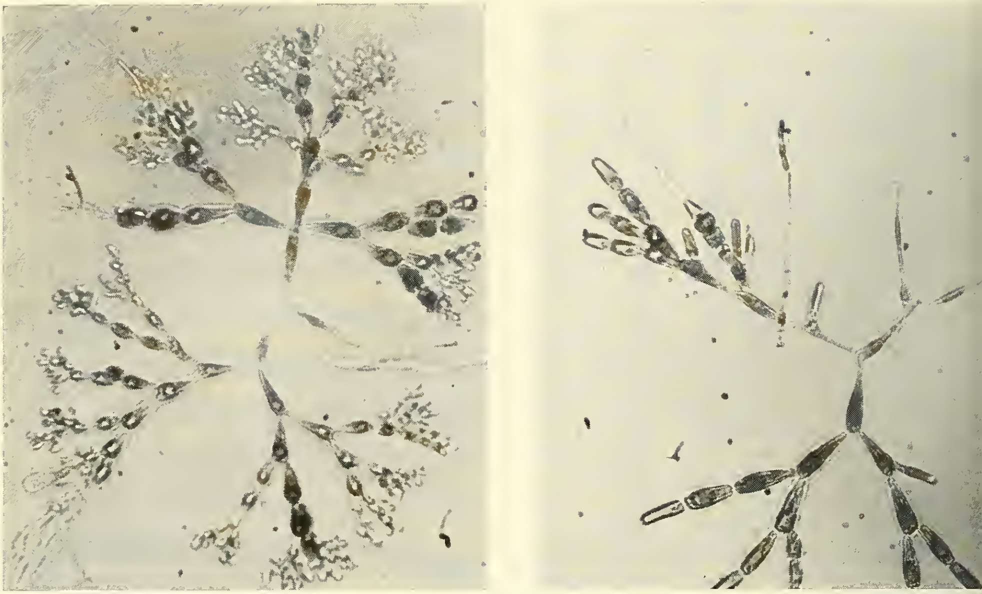
In this way a branch, composed of a number of cell filaments laid together in parallel arrangement, can acquire definite form and stabilized structure, much as a loose handful of wooden beads can be made rigid by driving nails or pegs between them. In addition, the cell chains are securely held in position relative to each other by a transparent, tenacious, gelatinous substance secreted by the outer part of the cell walls.

WHETHER the pit connections of the Florideae serve any other purpose than this mechanical function is not known with certainty; it is tempting, however, to speculate on the possibility that they also allow the transport of foodstuffs in solution from one cell to another.

The interlocking of simple cell chains in this way, together with their inclusion in a gelatinous matrix, allows a surprisingly large number of



CHAINLIKE ALGA, *Batrachospermum,* is composed of a central strand with tufts of filaments branching from it. Dark dots at right hold reproductive bodies.



REPRODUCTIVE CYCLE of *Nemalion* is seen in the micrographs above. Male spermatia at left are small budlike cells at the tips of filaments. Female carpogonium, seen in next p consists of a chain of four cells and a hairlike outgr

shapes and structural types to develop. This is especially evident when the cells themselves are modified in form according to their position and function, as is the case among the more highly developed red algae. A cylindrical or threadlike thallus can be built up by the attachment of an outer layer of radiating filaments to a central core composed of one or several longitudinal strands. This is the "insulated cable," or "feather boa" type of red algae structure. By joining many filaments side by side in a single plane, in turn, a flat, leaflike thallus can be produced—approximately the "rush mat" type. Whenever these vegetative bodies are more than just a few cell layers in thickness, we find that only the outer cells are equipped with the pigment-bearing bodies (plastids), which enable them to assimilate foodstuffs by photosynthesis.

None of the red algae reaches the colossal dimensions of the great brown kelps, but quite a few attain a respectable size, with fronds well over a foot in length. Even in quite large ones, however, often there is only a single, central cell filament present—running the entire length of the frond and usually protruding as a growing point at the extreme tip. This central filament may be immersed in a thick mass of surrounding filaments or peripheral cells, the number of the latter in some red algae, such as in the genus *Polysiphonia*, being constant for each species. Other types have many parallel central filaments, so that the growing tip, seen under the microscope, shows many apical threads fanning out in a fountain-like organization.

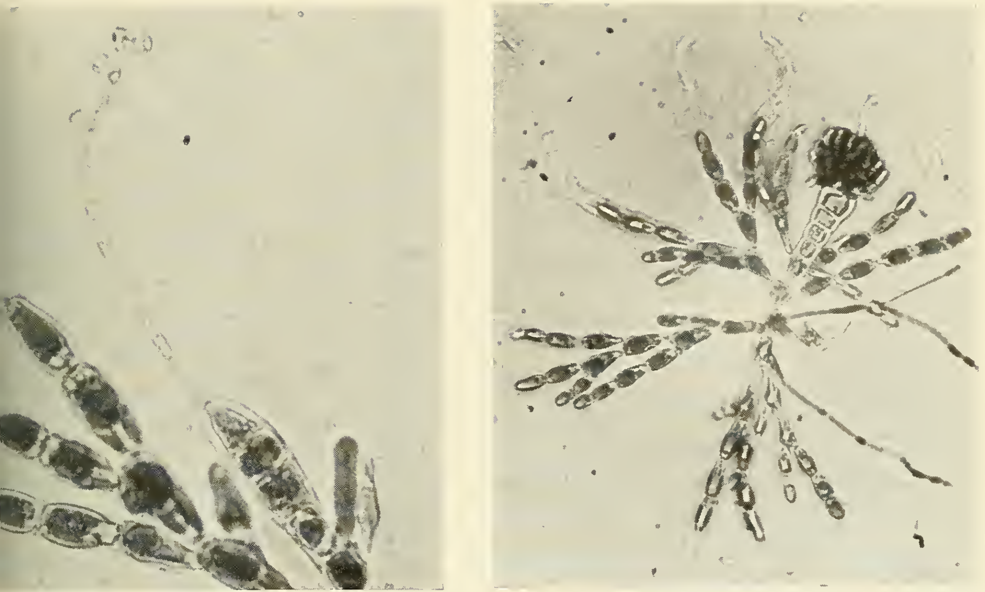
DR. LAMB, a previous contributor—his article on the lichens appeared in NATURAL HISTORY's February, 1958, issue—directs the Farlow Reference Library and Herbarium at Harvard.

MOST red algae possess a highly specialized type of sexual reproduction that involves the bringing together of two types of cell nuclei, usually regarded as "male" and "female," to form a fusion nucleus combining the hereditary traits of the two parents. These genetic characteristics are borne on the chromosomes—small, sausage-shaped portions of the nucleus—and the number of chromosomes in each comparable nucleus is constant for any given species. When the two nuclei fuse, the resultant double (or diploid) nucleus naturally contains double the normal number of chromosomes. For the plant to return to the number of chromosomes normal in a single (or haploid) nucleus, th is necessary to halve them. This complished, in all organisms h sexual reproduction, by a special of nuclear division—called redu division, or meiosis.

Bearing these facts in mind, l look at one of the red algae in v sexual reproduction takes place i simplest manner.

Batrachospermum is peculiar a the red algae in being a fresh- type. It grows on stones in cold, s flowing, inland streams, in such s locations as under rocks or bri and may be found in almost all of the United States where such tats occur. The field naturalist look for small, soft and slimy tu a gray, pale-green, blue-green violet color—paradoxically *not* since in this genus the red phycoe rin pigment is, according to the cies, either absent or else ove by a related pigment of a blue- color, phycocyanin.

WHEN taken from the water plant collapses into a gelat mass like frog spawn (hence its —from the Greek *batrachos*, frog *sperma*, seed). When floated out shallow dish and examined w hand lens, the alga shows a quite



d the trichogyne, against which the sperm drift and to h they adhere (third photo). Nucleus of sperm then moves down trichogyne into egg cell at its base. Finally, the fertilized carpogonium has begun to form cluster of spores.

beaded, filamentous structure. real surprise, however, comes a small piece is mounted in r on a glass slide and examined r the microscope. At this magnifi-n, the slimy mass is transformed a beautiful little plant. From a al strand of longitudinally paral-colorless threads, there arise at vals rounded tufts of branching ients that contain the photosyn-c pigments and which remind one eads on a string (photo, p. 19).

MARINE genus of the same order is *Nemalion*, which grows in slimy on rocks in the tidal zone in the of reddish-brown, wormlike, gel-ous strings several inches in length. structure, it follows the same rn as *Batrachospermum*, with a al strand of colorless threads ing lengthwise and an outer layer ranching filaments terminating in rless hairs radiating in all direc-. Here, however, the photosyn-c filaments are not clumped in rate tufts or beads, but are densely ded together along the entire th of the plant, which therefore not have the necklace-like struc-we have seen to be characteristic *atrachospermum*.

Nemalion or *Batrachospermum* is collected in midsummer, a low-power microscope or even a strong hand lens reveals numerous dense, rounded clumps of cells borne among the photosynthetic filaments. These are masses of sporangia—cells that liberate spores for the propagation of the species. Such sporangia (or carposporangia, as they are called in this case) are formed as the result of sexual reproduction. For these algae produce both male and female organs, usually close together on the same plant. The male bodies (known as spermatia) are minute, round cells produced in large numbers from the ends of certain of the filaments. Set free in the water in enormous numbers, they drift in the current until, by pure chance, some of them come into contact with the receptive female organ that they are designed to fertilize. In all red algae, the male cells are of this same, round type, lacking the whiplike cilia usually present in the male cells of other algae. So, their dissemination is a passive process, depending on the movement of the water in which they are liberated.

Meanwhile, the female organs have been elaborated on other filaments to await the arrival of the male sperm cells. Each consists of a short chain of unpigmented cells called the carpogonium, whose end cell is surmounted by an elongated, sticky, hairlike outgrowth (the trichogyne) especially adapted to receive the male cells.

SOONER or later, one or more of the male sperm cells will drift against the sticky trichogyne, and adhere to it. From this point onward, it would be difficult to understand the course of events without some inside knowledge of what takes place within the cytoplasm of the cell. Thus, for a moment, we will revert to our earlier discussion of nuclei and chromosomes.

Every cell of the plant body of *Batrachospermum* and *Nemalion*, including the reproductive cells, contains one nucleus with the single (haploid) number of chromosomes—this number being eight in *Nemalion*. When a spermatium fuses with the female reproductive organ, it empties its tiny nucleus into the receptive trichogyne: only its case, the empty cell wall, remains attached to the surface.

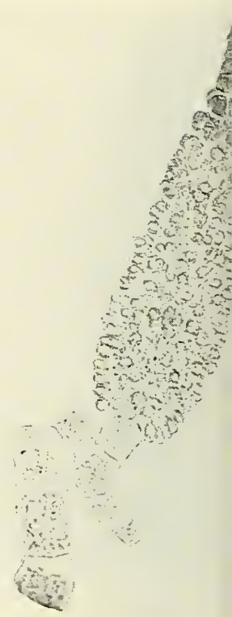
The nucleus of the spermatium, containing in its chromosomes all of the hereditary information about the parent from which it came, travels inside the trichogyne to the first cell of the chain, which it enters. This is the egg cell and, of course, it also contains one nucleus with the same, single, or haploid, number of chromosomes.

Now an event takes place that occurs but once in the life cycle of any organism—the fusion of male and female nuclei to form a single large nucleus, which, having the double number of chromosomes, is called diploid, as we have seen. The life span of the haploid generation has terminated for the time being, and the fertilized egg cell represents a second phase of existence, in which chromosomes in the cell nucleus are paired up in duplicate.

In *Batrachospermum* and *Nemalion*, this second, diploid, generation is of the shortest possible duration. It is confined to the fertilized egg cell alone, for as soon as this fertilized egg undergoes its first partition, meiosis—the special type of chromosome-reducing nuclear division we mentioned—takes place. The duplicated chromosomes are torn asunder, and only one of each kind is bestowed upon each of the daughter nuclei.

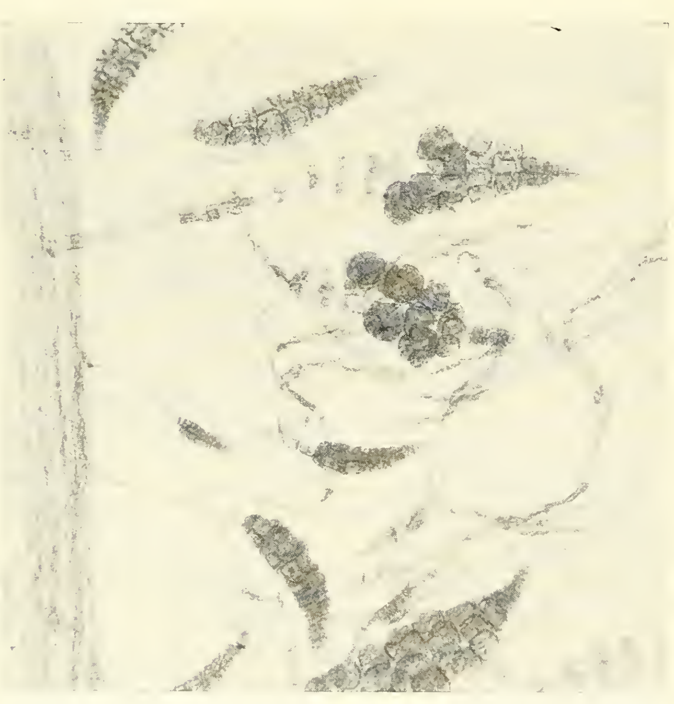
The clumps of minute carposporangia, which have already been described as dense specks found among the plant's photosynthetic filaments, are produced as the terminal cells of a number of short, compact, and crowded filaments formed by the divisions of the fertilized egg cell. Since reduction of chromosomes took place at the first division of the fusion nucleus, it follows that these carpogonial filaments, and the spores that they produce in their terminal, carposporangial cells, are haploid like the rest of the vegetative plant. The spores, on being liberated and settling on a suitable substratum, germinate to give rise to new *Batrachospermum* or *Nemalion* plants.

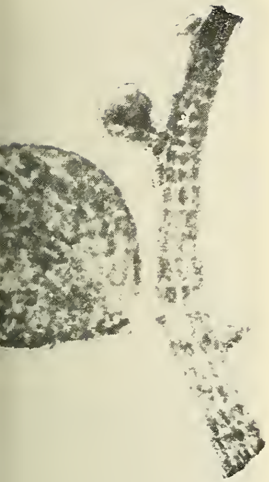
This condition, in which the diploid phase of the life cycle is represented only by the fertilized egg cell and which terminates on the latter's first division, is a primitive one in the red algae. On this account, *Batrachospermum* and *Nemalion* are rated as primitive forms. We know for sure that any plant of these two genera that we pick out of the water belongs to the haploid generation. But in other, more highly evolved types of red algae, this is not the case—these have an alternation of two generations, haploid and diploid, growing as sep
plants and usually indistinguis
from each other as regards their
tative characteristics.


CONE-SHAPED growths, not simple
of filaments, bear spermatia in

Such complications in the life
arise, basically, from the post
ment of meiosis to a later stage
organism's development. Not o
the fertilized egg diploid, bu
carposporangial filaments and
spores to which the egg gives ris
have diploid nuclei. Furthermor
spores, when they germinate,
into diploid plants, of the same ap
ance as the haploid ones, so tha
less reproductive structures are
ent, it is impossible—short of cou
the chromosomes under a micro
—to tell whether the particular
that we have gathered is of the ha
or the diploid generation. This
phenomenon known to botanis
alternation of generations. It is
widespread in the plant kingdo
though often little noticed on ac
of the extreme reduction in size o
of the two, alternating generatio
most instances the haploid.

As an example of red algae in
this more complicated pattern o
cycle occurs, we may cite the m
genus, *Dasya*, a stringy form


TETRASPORANGIA, cone-shaped growths found among the alga's photosynthetic filaments, take place of sexual organs in diploid second generation of *Dasya*.



ICAL CAPSULE or cystocarp bears clusters in the higher red algae.

a foot in length and profusely hed, with fine, photosynthetic nts spreading out in a fringe of te, reddish hairs along their en- ngth. This plant may be found d up on sandy beaches from Cod to Florida.

Dasya, we meet with a much eater complexity, not only in the ating generations of haploid and d plants, but also in the structure reproductive organs themselves, nally in a series of peculiar cell s that occur immediately after g cell is fertilized.

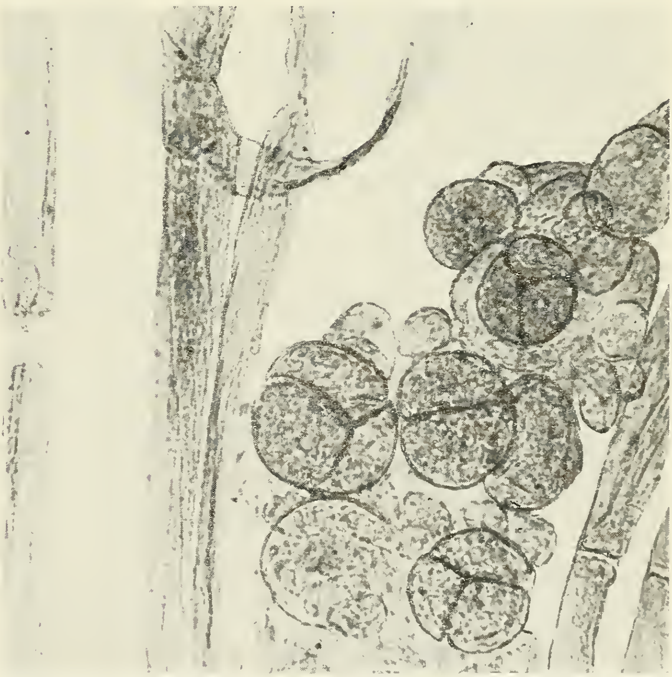
male spermatia of *Dasya* are d, not on the ends of ordinary synthetic filaments, but on spe- cone-shaped structures originat- side outgrowths from these fila- . The female carpogonium, in consists of a short chain of cells, rminal one being the egg cell, ounted by a long, receptive trich- (drawing on p. 24; figure 1). is chain is curved in upon itself, at the egg cell comes to lie not r away from the supporting cell e bottom of the chain. One or spermatia, washed against the gyne, stick to it (figure 2); and the nucleus of one of them migrates downward into the egg cell to fuse with its nucleus.

Now, two things happen almost simultaneously. The supporting cell at the bottom of the carpogonial chain proliferates a second, rather large cell called, for reasons that will become clear presently, the auxiliary cell (figure 3). At the same time, the egg cell, itself, buds off a small, connecting cell that bridges the open space between it and the auxiliary cell in the curve we have mentioned (figure 4). With this auxiliary cell, the budded connecting cell fuses, so that the whole complex now takes on the form of a closed ring.

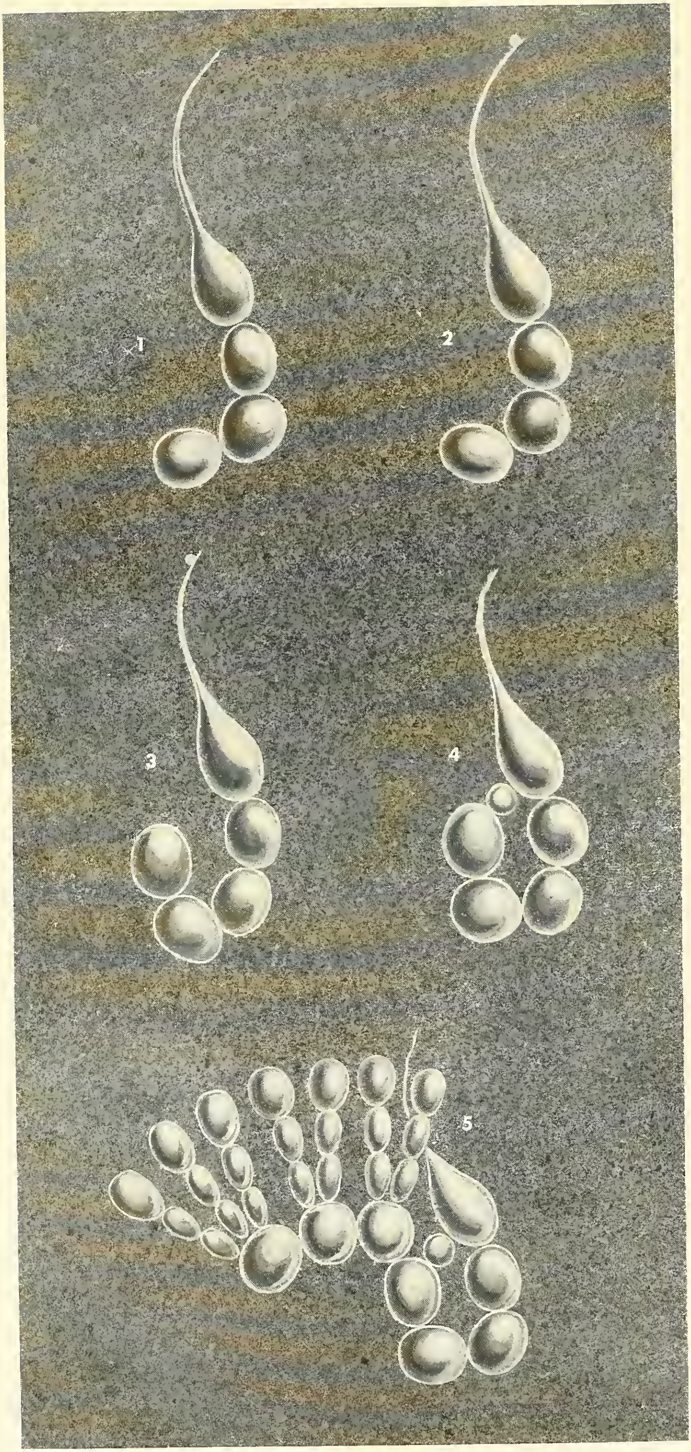
The diploid fusion nucleus of the egg cell now migrates, via the small connecting cell, into the auxiliary cell. The haploid nucleus of this auxiliary cell is pushed to one side and takes no part in the subsequent proceedings. Now, from the auxiliary cell, a chain of a few new cells buds out, each of which receives a diploid nucleus from repeated divisions—but *not* reduction divisions—of the original fusion nucleus. These latter cells now give off a number of smaller cell chains that terminate in carposporangia similar in appearance to those of *Nemalion* (figure 5); but they all contain not haploid, but diploid nuclei, because *no* meiosis of the original fusion nucleus or its descendants has yet occurred.

While all this has been going on, a spherical envelope of cells from the sterile cell tissue at the base of the carpogonium has grown up around the developing spore cluster. By the time the spores are ripe, this protective capsule (the cystocarp) encloses them completely. They are liberated, a few at a time, through an opening at its apex.

This migration of the fusion nucleus *out* of the fertilized egg cell into another, auxiliary cell (which performs a nutritive function) is found in no other group of plants but the red algae. The spores of *Dasya* finally settle on the sea floor, and those that encounter favorable conditions germinate and grow into typical-looking *Dasya* plants. These diploid plants are genetically different from their precursors. We might expect this profound genetic difference to be reflected



CLOSE-UP shows separate cells of some tetrasporangia. Word comes from Greek *tetra* (four)—since when matured each of these structures consists of four cells.



in the size or appearance of the p
but this is not so in *Dasya* or i
majority of red algae exhibiting
nation of generations. As we
already said, unless reprodu
structures are present, it is quit
possible, on ordinary inspection,
whether a given individual pla
haploid or diploid.

BUT by their fruits shall ye
them: the diploid *Dasya* c
second generation produce no s
organs but, instead, bear as their
agative organs another type of
angium (called a tetrasporang
Greek *tetra*, four—since it is divi
maturity into four cells, each of
produces a single spore). In *Da*
and many other red algae wit
same type of life cycle—the four
of the tetrasporangium are clu
together in a ball, with three
cells visible in surface view an
fourth underneath.

The formation of these tetr
angia is connected with the secon
event in *Dasya*'s reproductive c
the corollary of nuclear fusion—
ly nuclear reduction. The splitt
the double nuclei to bring about
of the single (haploid) chrom
number has to take place at som
or another in the life cycle. As w
in *Nemalion* and other primitive
of red algae, this took place in
ately after fusion, at the nucleu
division. With *Dasya*, it is duri
two nuclear divisions in whic
four cells of the tetrasporangiu
formed that meiosis—and halv
the diploid chromosome nu
finally takes place. Therefore,
each of the four tetraspores is
ated and germinates, it contain
one haploid nucleus, and grow
a haploid plant of the type with
we started our study. A fresh a
tion of generations has set in, a
are back at the beginning, wi
life history of this advanced f
alga repeating itself anew.

MANY red algae have evolv
capacity to extract lime
sea water, and to deposit it i
tissues, either in the form of gr
or spicules, or as a solid casing
cium and magnesium carbona
cified red algae vary from
lichen-like crusts on the rock
the genera *Lithophyllum* and
thamnion—to upright, branche
articulated structures resem

ls. One of our common coastal ies. to be found firmly attached to s at or just below the lowest ebb- level. is of this latter type. Its l, rigid stems are rough to the h and divided with geometrical ision into jointed segments. It was ed *Corallina officinalis* by Lin- is on account of its markedly coral- appearance.

ime-encrusted red algae of this readily leave their characteristic rints in rock formations, to be pre- ed intact for millions of years to e. Representatives of calcareous algae. very similar to living forms, found in rock deposits dating back ie Cretaceous period of the Meso- , 140 million years ago. However, r, non-calcareous types of red al- of quite high evolutionary special- on. appear to go back much ier than this—possibly to the Cam- n period. at the start of the Paleo- Era. Thus. the group as a whole viously an ancient one among the ts, having already evolved, 400 ion or more years ago, to forms parable to those of today.

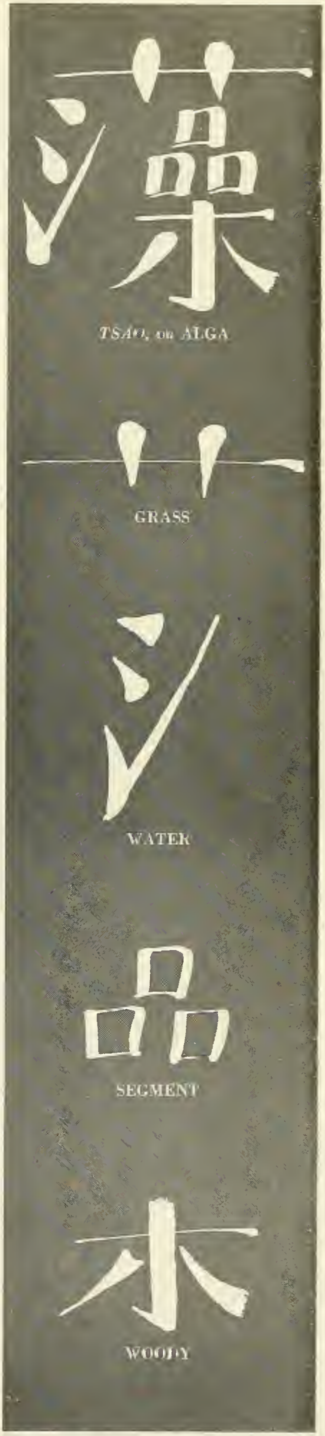
CH fossil finds as this must stimulate our curiosity as to how the algae, as a natural group, origi- d in those remote epochs, when had comparatively recently made ppearance and was still confined ır planet's ancient seas.

ertain of the most primitive exist- red algae seem to show a remote ionship with another very ancient ıp of algae, the blue-green algae *inophyceae* or *Myxophyceae*). The rrence of the same pigments— ocyanin and phycoerythrin—in in members of both these groups, nowhere else in the plant kingdom, orts this view substantially. Yet, ie blue-green algae, propagation s place only by vegetative divi- and sexual reproduction is un- vn. Although it seems logical to ose that, at one time or another, ecting links between the two ps must have existed, these links certainly now become extinct.

ne of the fundamental principles volutionary progress in all living nisms, as deduced from the ob- ed history of forms well repre- ed in the fossil record. is that strik- innovations in structure or func- are never derived from highly ved, climax groups of the parental k but, instead, always arise from unspecialized, lower groups—often of great genetic plasticity—which have descended relatively unchanged alongside of the more complicated forms. This helps explain why. in some extremely primitive red algae, we find radical departures from normal standards; for example. occurrence of creeping, amoeboid carpospores—bare cytoplasm, with no cell walls—in *Porphyra*. when all other red algae have strictly non-motile reproductive bodies. It would seem that in *Porphyra* we are witnessing the emergence of an entirely new evolutionary trend in the group. The same may well be true of the few red algae like *Batrachospermum*, which inhabit fresh-water streams. Significantly enough, almost all the fresh-water red algae belong to primitive, unspecialized families.

HENCE, we may reasonably draw the conclusion that red algae represent one of the most ancient forms of plant life existing at the present day, that they have always inhabited the sea, and that the migration of a few families into fresh water is a relatively recent evolutionary trend. The elaborate reproductive processes that the red algae show are in themselves a sign of antiquity: more recently evolved groups of plants, once they have adapted to their environment, tend to undergo simplification in this respect.

In point of fact, there is something rigidly geometrical and conservative in the anatomical structure of the red algae, which we do not find in presumably more modern groups of plants, like the higher fungi. We find the same sort of difference, in general terms, between the geometrically constant growth-form of the cone-bearing trees (gymnosperms) and the irregular, adaptable, more opportunist type of growth and branching in the more recently evolved. flowering trees (angiosperms). Was some concept of this kind in the mind of the Chinese sage who first invented the ideograph for algae (illustration at right), one of whose symbols stands for regularly arranged segments or cells? Whether or not the exceedingly regular and beautiful structure of these ancient plants was duly appreciated in those far-off days. it is certain that for us, today—with the aid of a low-power microscope or hand lens—the red algae afford as fascinating a subject for study as will be found anywhere in the wide domain of natural history.



The Fligh
# of Birds

Photography offers a new w
to study this elusive behav

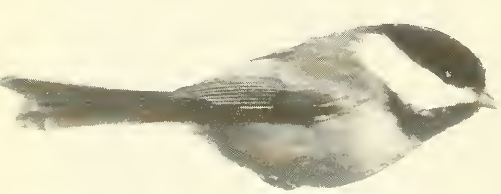
By Wesley E. Lanyon

Long before man mastered the air at Kitty Hawk. he had marveled at the wondrous spectacle of birds in flight. In spite of today's technological progress in the design and control of "flying machines" and the imminence of man's travel through outer space. birds remain without peers in the realm of true flight. We ask ourselves. being intellectually curious and perhaps a little vain. why this should be so. How. in fact. *does* a bird fly?

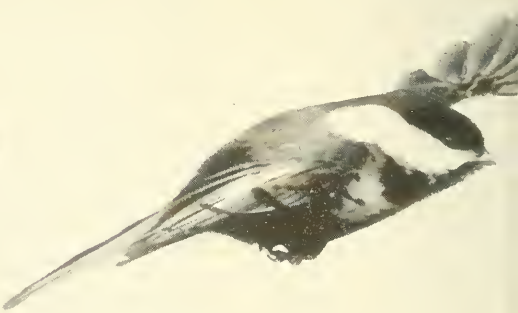
Flight is the most characteristic attribute of birds. and has played a dominant role in their origin and evolution. The primitive ancestral bird probably rose from a generalized type of reptile. during an era when highly specialized groups like the pterosaurs. or flying reptiles. were among the dominant animals. The development of flight was necessarily dependent upon adaptations to meet the seemingly conflicting demands of economy of weight and the rigidity and strength of structure. and we can but speculate on its origin. Some scientists look to arboreal reptiles as the ancestors of birds. and suggest that flight began with a primitive gliding motion. Others have postulated that flight originated among bipedal reptiles that "flapped their forelimbs" as they ran. In time. the scales of the forelimb enlarged and flattened into feather-
like structures that increased the efficiency of the "w

Although none of the flying reptiles survived to pr
time. less successful types of flight or simulated
were developed independently among other an
groups. Certain fishes, for example. "fly" by sprea
their fins and gliding on air currents above the w
But they receive their propelling force from vigo
movements of the tail. rather than from the outstret
fins. Flying squirrels are able only to glide. by v
of folds of skin spread laterally from the body.
have achieved true flight, through the use of membr
stretched between their limbs. but they lack many o
advantageous adaptations that have been evolved by b

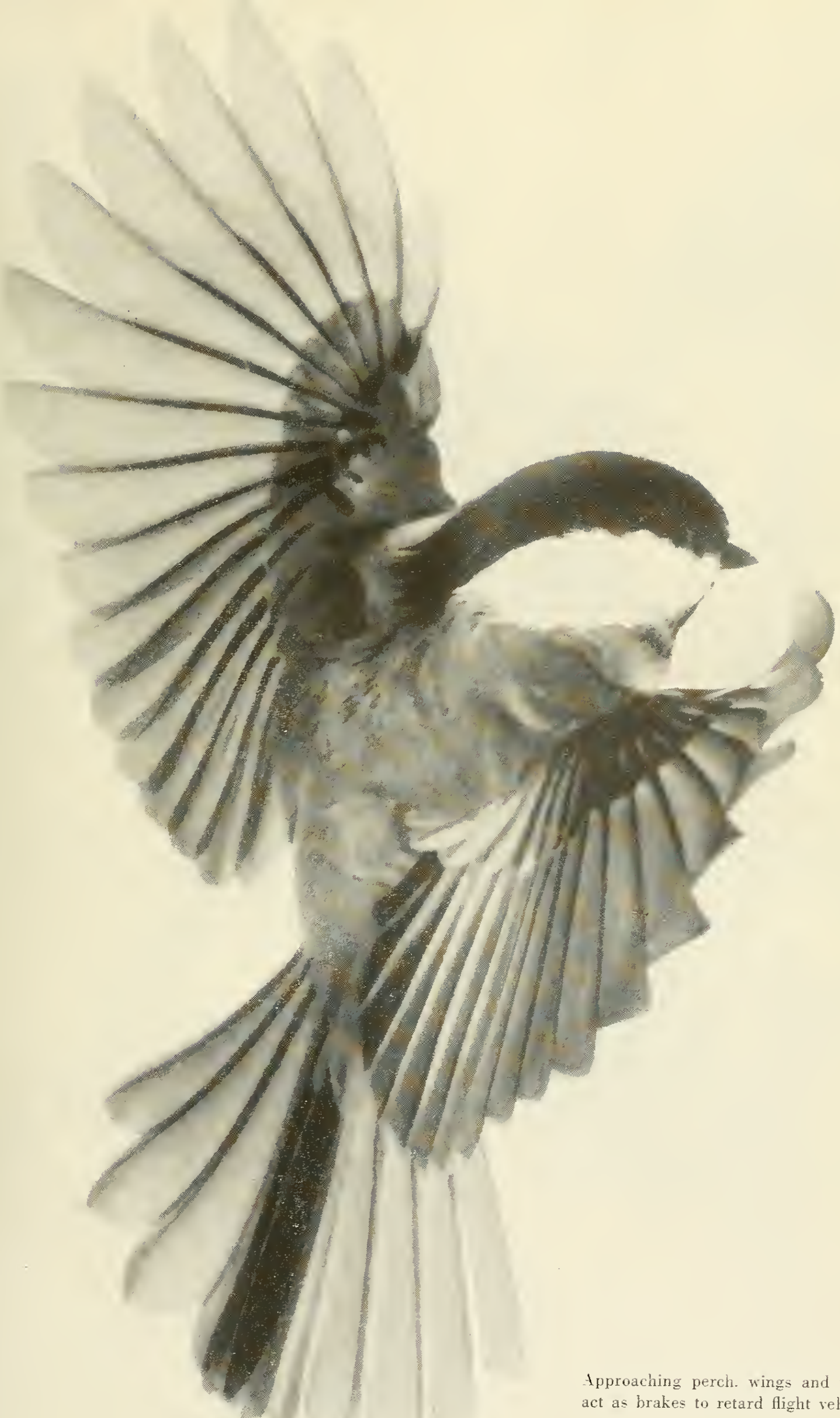
Certainly the development of feathers and their co
is one of the secrets of the success of birds. An
neering masterpiece. the feather combines the desi
attributes of lightness. flexibility. and durability.
feather coat provides an efficient. smooth, and virt
airtight body surface. The bones of birds are remark
light—often hollow or porous—yet are adequate to fu
the support necessary for the stresses of flight. Some
become fused together. thereby increasing rigidity
compactness. The air sacs that penetrate many par



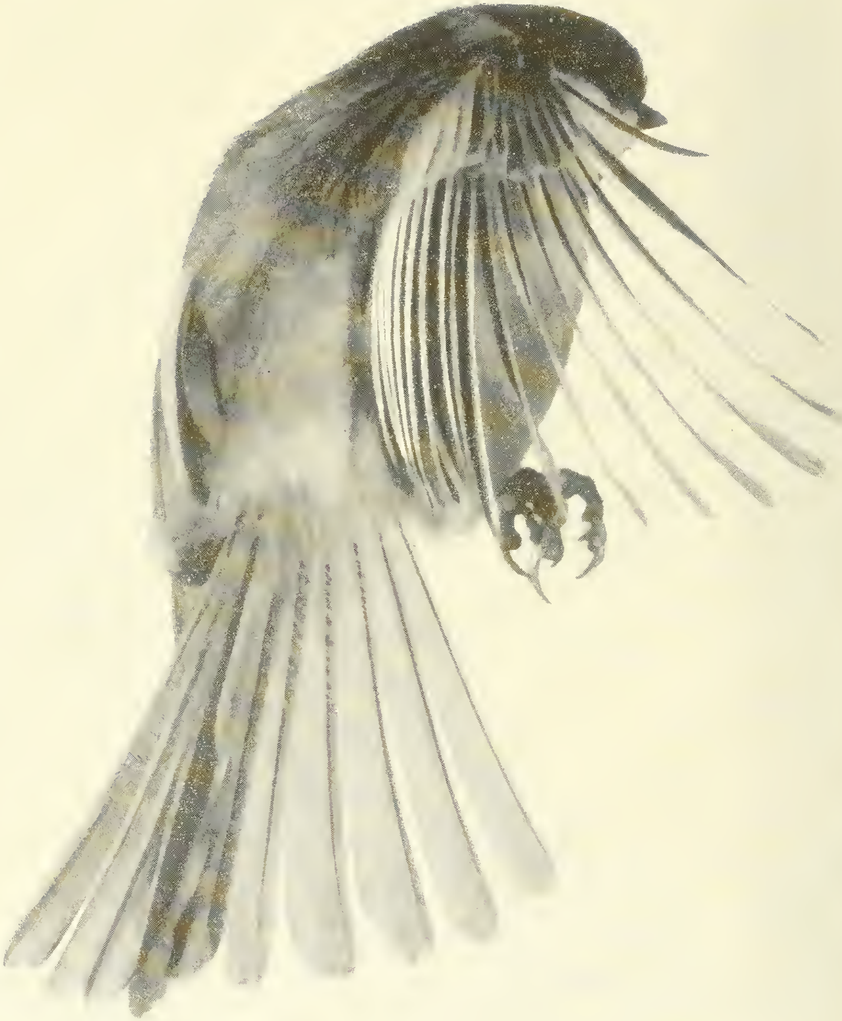
Chickadee's short flight pattern
is facilitated by long, supporting tail.



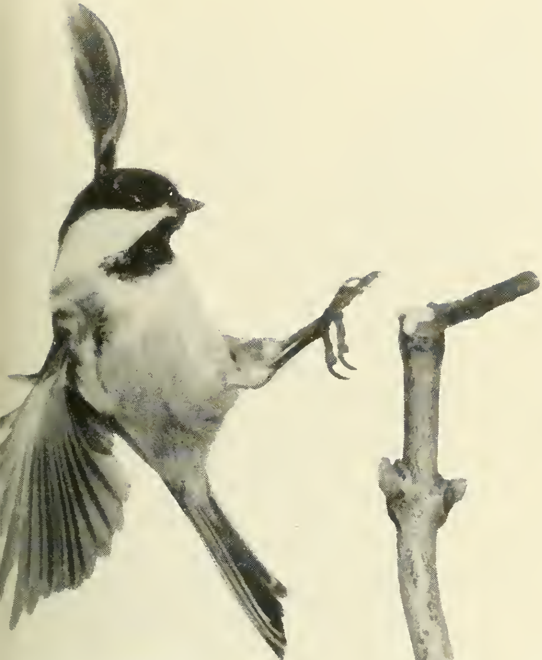
Tips of primary feathers act as
propellers: rest of wing provides



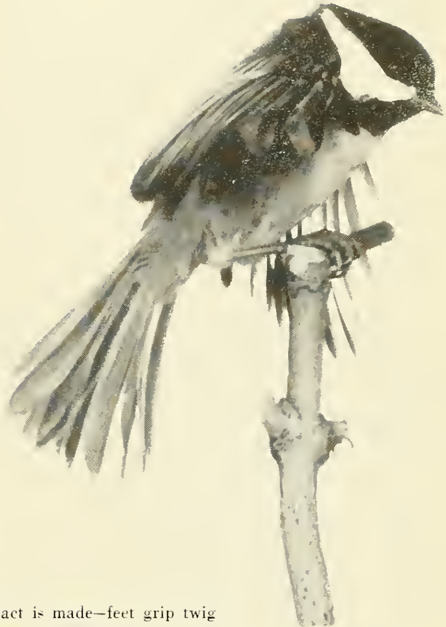
Approaching perch, wings and tail act as brakes to retard flight velocity.



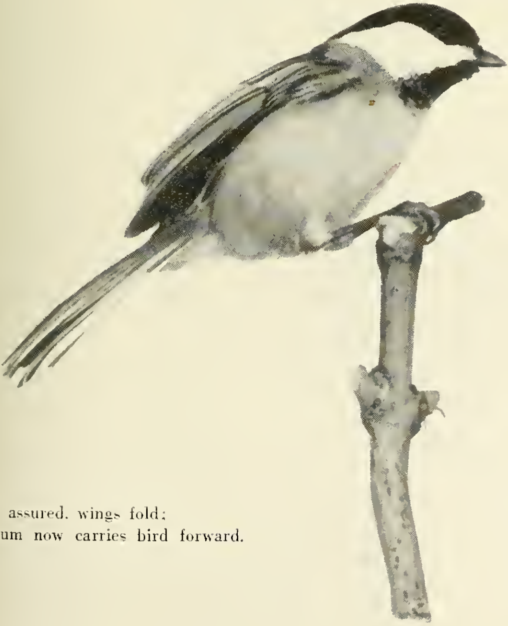
Within eight inches of target, chickadee, still checking its speed, begins to lower its legs.



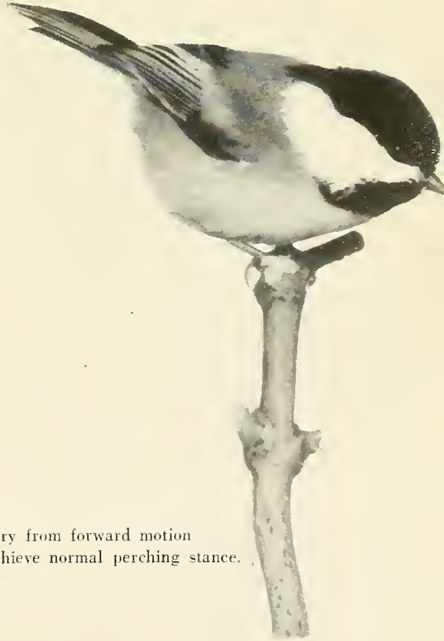
legs fully extended. bird
ady to make contact with perch.



Contact is made—feet grip twig
as wings work to maintain balance.



nce assured. wings fold;
entum now carries bird forward.



Recovery from forward motion
will achieve normal perching stance.

the body, including some bones, probably increase flight efficiency. The bulk of the musculature, particularly those parts controlling the wings and feet, is located nearer to the center of gravity than the extremities as in many animals. No teeth, the abbreviation of internal organ systems, and the rapid elimination of body wastes are additional adaptations for weight economy.

The many kinds of birds differ in the way they fly: each species has evolved a wing that is best suited for its particular way of life. Within this range of variability, however, all have adhered to certain basic features. The streamlined body contours are essential for reduction of air friction and turbulence. The wing of a bird, when viewed in cross section, is thickest at the leading edge, and gradually tapers to a thin, trailing edge. This same efficient design is exemplified in each of the longer wing feathers, or primaries, as well, wherein the thickened shaft is located closer to the leading edge of the feather. The upper surface of the wing is invariably curved convexly, whereas the lower surface is straight or concave. This arrangement of the "airfoil" results in a reduction of air pressure above and an increased upward pressure or lifting force below. Birds are capable of increasing the amount of lift by tilting the wing. Too much tilt, however, destroys this lift, and results in a stall. The stream of air no longer follows the airfoil of the wing; the difference in air pressure on the two wing surfaces changes to a backward pressure, or drag.

A bird's wing serves in a dual capacity, performing the functions of both the wing and the propeller of an airplane. The inner half, or "arm," bearing the secondary and tertiary wing feathers, corresponds to the wing of the airplane. It supplies the greater share of the lift necessary to keep the bird aloft. The outer half, or "hand," bearing the primary wing feathers, corresponds to the propeller, and accounts for the forward motion. The longer, outer primaries are a vital part of a bird's flying equipment—their loss seriously impairs flight.

For many years a popular misconception of the mechanism of bird flight was the belief that as the wing beat down the bird was lifted up and forward. Our high-speed photographs today suggest that the process is not nearly so simple. In normal flight, the outer half of the wing moves in a semicircle. On the downstroke, the wing tip moves downward and forward, with the tips of the primaries twisted in such a manner as to drive the bird forward with a propeller-like action. The inner half of the wing moves comparatively little, yet supplies the necessary lifting force at all times, regardless of the flapping action of the outer portion. On the upstroke, the wing tip moves upward and backward, pressing against the air and hence continuing to push the bird along. A figure eight is thus described by the wing tip in the course of these two components of flapping flight. In the smaller, faster birds, the air pressure on the upper surface is often reduced by partial folding of the wing, in which case the upward—backward stroke is used primarily for a rapid recovery of the wings to the raised position without producing a significant forward thrust.

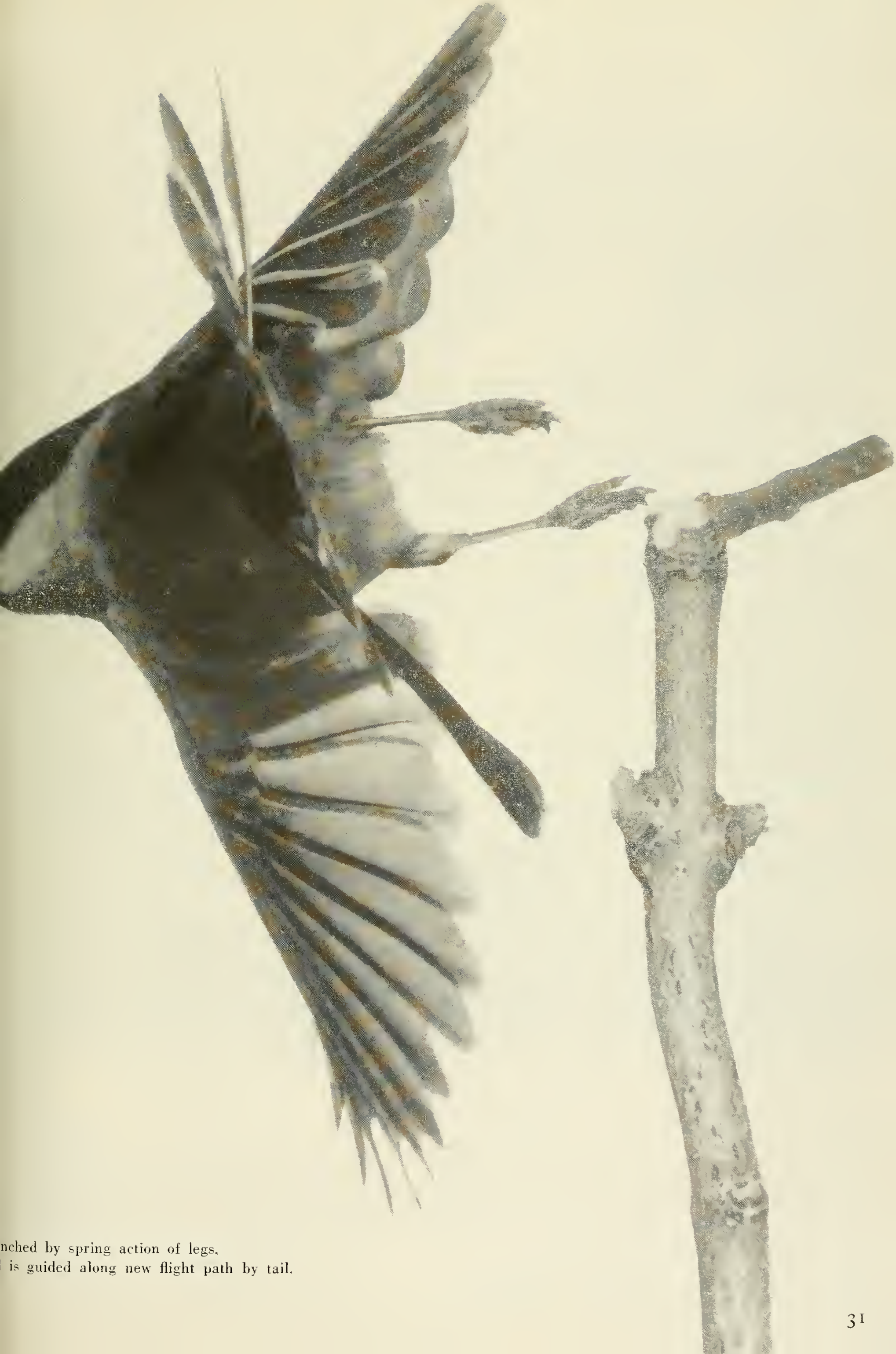
When an airplane reduces its speed, flaps along the trailing edge of the wing are lowered so as to increase lift. Birds may accomplish a similar effect by rotating the entire wing and by using the tail as a flap. These devices for increasing lift at lowered speeds are especially important upon landing, where forward speed m be retarded to insure against injury. Additional mea for preventing stalling are the apertures, or "slot between the tips of the outermost primary feathers. Th increase lift by making the air flow fast and evenly o the upper surface of the wing. In some species the out most primaries are notched to create more efficient sl Maneuvering, turning, and twisting is accomplished chie by adjusting the relative pressure against each wing.

The major interests of Dr. Lanyon, Associate Curator of The American Museum's Department of Birds, are the behavior and systematics of closely related bird species. The remarkable chickadee pictures were taken by Henry C. Johnson, a free-lance photographer in Hart, Michigan.

In addition to the normal, flapping flight describ above, there is a second general type of flight—soar or gliding. Soaring birds take advantage of currents air—called thermals—and rise or sink, depending u the power of the rising air and the advantage the bi take of it. Air currents that are deflected upward al mountain ridges or shore lines are the reason for numbers of soaring birds commonly observed over su topographic features. Soaring birds have comparativ light wing loads. While the tiny chickadee shown he which weighs less than half an ounce, may have a w load of 0.3 pounds per square foot, the five-pound v ture may have a wing load of only 1.1 pound per squ foot. The chickadee, with so small a wing area in relat to body weight, must flap its wings rapidly—up to f times per second. By contrast, the herring gull, wh has long, narrow wings, need only flap its wings two three times per second. In general, the smaller the w in relation to body weight, the faster it must beat provide sufficient lift.

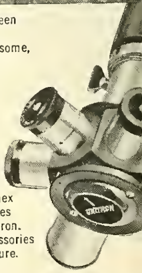
Soaring birds usually have wings that are long in re tion to their width—engineers say that they have high "aspect ratio." Birds vary tremendously with resp to the aspect ratios of their wings, depending upon types of flight patterns required for their particular w of life. Most songbirds, for example, have an ellipti wing of low aspect ratio that permits them to maneu more effectively in close quarters. Swallows and falco have wings adapted for high speeds, with a moderat high aspect ratio and wing tips that are tapered a lack slots. The albatross and other oceanic soaring bi have wings of extremely high aspect ratios, with the wi tip slots absent or poorly developed. The slotted soar wing, as evolved by certain birds of prey, combines moderate aspect ratio with pronounced slotting at tip, thus insuring excellent lift.

Attempts to better understand the flight of birds ha been plagued by the multiplicity of variable factors volved. Consequently, the experimental analysis of b flight has thus far been impossible. High-speed phot raphy has been a promising approach, however, and is largely to this technique that we owe our present kno edge of how birds fly. The interpretation of what camera sees is based upon principles of aerodynami Comparisons made between man's "flying machines" a the way in which birds demonstrate these principles ha been most enlightening. Among other things, scienti quickly discovered that the wing of an airplane is far l complex than a bird's flexible, jointed, magnificent wi



nched by spring action of legs,
is guided along new flight path by tail.

Johnny isn't watching the lat



The shadows that shiver and shake on the TV screen are shivering and shaking in
nebody else's living room tonight. Johnny has discovered something new.
He's traded the fleeting, flickering "thrills" of the 24 inch screen for the
eless excitement and majesty of the night sky.
He's traded the nervous rattle of the private eye's gun for a ringside seat at
stupendous nightly fireworks in the heavens.
He has, in short, discovered astronomy.
Nothing better could happen than what happened to Johnny. And it happened simply
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s of special educational inserts.

Little Climates

By E. LAURENCE PALMER

HREE MAJOR ASPECTS of what we shall call 'little climates" will challenge the interest of all of iring the coming year. As this is written, only one e higher vertebrates has had firsthand experience one of these aspects—and she cannot be profitably viewed on the subject. Thousands of human beings been killed by the second aspect and many other sands have had minor experiences with it. It is ble (but we hope not probable) that most of us experience this second aspect unexpectedly in the ediate future. As to the third aspect, it is certain all of us have had and will have experiences with roughout our lives.

the interest of mastering outer space, we have d a little monkey—protected by an elaborate little ite—far from the surface of the earth. If any of us a trip to the moon in the future, we will have protected by a little climate more elaborate than ing that has yet been developed.

ould a nuclear war break out, those of us who ve will have to know how to find a spot where iologic needs may be met until the danger passes— does. This possibility we elect to avoid considering Instead, we hope to help you understand the universal and the more important little climates surround you as you read this—climates about n you can do something and the understanding of n may well make you healthier, wealthier, safer, it may be hoped, happier.

rough the co-operation of an air-conditioning m and a gas furnace, the thermometer beside my ow reads approximately 70° F. throughout the I enjoy looking through this window to another is at right angles to it, only a few feet away in my g room. Between these two windows is an open in which the temperature may be as high as nearly or as low as −20°. I do not enjoy these extremes mperature. If I look from the house through one ese windows across the open space to the other I e that in the daytime the window nearest me is and the one opposite is dark.

hen, in the spring, the temperature outside my ows gets to about 50°, I frequently notice sluggish- ng cluster flies on the outside woodwork. They pear when the temperature drops much below 50°. may be seen crowding against the outside of those ows that are dark from the outside. If they manage et inside, they find that the temperature there is e 50° and they then try to get through the window more—this time from the bright side. Knowing do that when the temperature is below 50° they darkness and contact and when it is above 50° seek light and avoid contact, I can do something t their management.

When it is bright and warm and the flies swarm against my sunniest windows, trying to get out, I open the windows and let them go. When it is cool and they wish to get back in again, I close the windows—and that is that. If we can control light, heat, moisture, and the other factors mentioned in the following chart section of this article, we can control a surprisingly large number of things. Some of these must be controlled if we, ourselves, are to survive.

If we wish, we may recognize three types of climate on the basis of size. More commonly, writers distinguish between the climates of areas on the basis of only two sizes. They say, for example, that the climate of parts of a garden are "microclimates," while those of greater areas are "macroclimates" or just "climates." Here, we elect to consider only the climates of areas under a cubic inch in size as being microclimates and those of areas from a cubic inch to a thousand cubic feet as being "little climates." We can control conditions in a climate of a single cubic inch rather completely. We can do much about a climate a thousand cubic feet in size. But individual areas larger than that call for pooled efforts such as do not concern us here.

In this study, we have selected eighteen factors that may influence any climate—large or small. In our chart, we have indicated some of the more important aspects of each. Since any of you can surely control the physical conditions in an area of a few cubic inches, you might try to learn the effect of the factors we will consider by simply changing conditions in such an area and observing what happens. For example, shut off the light, change the temperature or the pressure of air, water, or soil on a given spot and see what happens. Do this for a short or for a long time to see if this factor of time has significance. Then investigate the possibility suggested by other proposals.

A SERIOUS competition seems to be developing between the agriculture of the U. S. and of other lands. Why, for example, can we plan our food production so that twelve per cent of our population can produce not only enough to feed us all but to accumulate embarrassing surpluses, while the U.S.S.R. uses fifty per cent of its population to produce an inferior return? Our success lies mostly in our ability to recognize significant little things in our environment. We know that, with the proper use of fertilizers, irrigation, cultivation, and labor, one farmer in good situations can produce a bushel of corn for every three minutes of human labor. We know that the land can produce corn with little rotation of crops with the help of fertilizers that industry produces in part from the atmosphere. We know that chickens provide a superior means of producing useful protein from corn but that they do not use effectively the non-fruiting parts of the plant. We know that hogs and cattle can use this non-fruiting part effectively in their diet. By little climate management, we can control insects and fungi, and produce hybrid seed, making this whole cycle possible.

It is doubtful if any readers will object to considering light, temperature, or pressure as factors of the little climates. Obviously little climates can be most effectively understood if we know about states of matter and the physical and chemical nature of matter to be found in our little climates. Most important changes in little climates involve the physiology of plants and animals, which, in turn, involve chemical and physical changes that must be appreciated.

We elected to include sound as a factor in little climates not because it is as fundamental as chemical and physical changes but because it may have more significance than we might at first think. Offhand, we speak of a neighborhood as being "nice and quiet" or "noisy" and values attach to these differences. We go to great expense to install mufflers and to use wall coverings that are sound-absorbent, yet we rely on sound for much of our communications and a good deal of our enjoyment. By mechanical representations of natural sounds we can call animals to their death so effectively that we have laws limiting this use of sound. We use sound waves in surgery, in psychology, and in other ways. Mechanically, we can magnify the sound of a moth chewing wool to the point where it is audible to us. If necessary, we could similarly magnify many other sounds of nature that we cannot hear.

To a considerable extent, the time element figures in the success of a little climate. Most of us can dive safely into a lake, remain submerged for a time and then come to the surface and renew our normal breathing. Plants and animals of little climates vary greatly as to the length of time during which they can suspend breathing: survival may hinge on ability in this field. The nature of such threats to an organism's survival is important, of course: a man or a louse might survive a few minutes under water, where either could survive only a few seconds in a blast of flame. Organisms vary, too, in their ability to survive if a portion of their bodies is subjected to a severe influence while the remaining portion is not exposed. This happens particularly in plants, in which—as in the common marsh fires, for example—the underground parts may have the protection of the earth while the tops burn away. Sometimes destruction of a part of an organism may be advantageous and sometimes—as in the case of some pine cones—exposure to a fire may be necessary if the seeds are to be freed. Then, a little climate—protecting a cubic inch or so of a plant or animal—may be all that is necessary to perpetuate a species in a given locality.

Short periods of time in which protection is available are also frequently important in connection with the breeding cycle. Eggs or helpless young may need abnormal luck to come through the crises they experience early in life. Frequently these critical periods seem to be synchronized with the times when nature provides a maximum of protection. If alternate food for an enemy is available in abundance for just a short time, the individual's chances for survival improve.

OF COURSE there are other material factors tha be considered in understanding little climate concepts of time and of the mechanical and pl nature of matter, of light, sound, and pressu important—but not so objectively evident as air, and soil. Rarely in nature do you find air without vapor or mineral dust in it. It is almost as unco to find water without minerals dissolved in it or out air present in it. Our study then concerns things not as entities but as mixtures of differen portions. Little climates will vary remarkably ow these differences in proportion.

If we look at almost any organism carefully, v probably find it tremendously influenced by eith or soil. Some of the readers of these pages found interest in our previous mention of the kudz crown vetch. We may be concerned about ho and persistently kudzu grows. We can see it in in length a foot a day and find that it penetrat soil to depth of over a dozen feet. A single may grow as much as a hundred feet in a yea plant may yield three and one-half tons of hay acre a year, but this may be insignificant compa the fact that a cover of kudzu can keep the soi perature down to 5° below what it is in an ad field, and that the lower temperature means a tion in the loss of moisture—a factor that could the greatest importance. Most legumes establish relationship with nitrogen-fixing bacteria. These in fixing nitrogen from the air so here we have that can penetrate the soil deeply, can use nitro the air, can keep the temperature down and redu loss of soil moisture. Air, water, and soil are al essary to their existence and they bring the thr gether to perform useful functions. They make own little climates once they can become estab and these, if suitable to our needs, can be of great

The interrelationships between air, water, an are remarkably close so far as concerns almost the little climate factors here considered. Light considered here as being available. But the light, ing the soil, may raise its temperature—causing of water in the soil to form vapor in the air. materials in the air, in the form of dust, may volved in causing precipitation or may shut the off from the soil and cause a variety of chan importance. It is thus easier to think of combin of air, water, and soil than it is to find any one o in a pure, independent state. So important are three that we now have great numbers of perso organizations grouping together to guarantee th three may be available for a given area. We have shed commissions, antipollution organizations, smog-control groups—all of them concerned with lems that may seem remote from little climate each of their concerns is merely a magnificati the same little units, which you may learn to stand by experimenting in your home, your own yard, or in a few cubic inches of your garden. A drop of water on unprotected garden soil may cycle that, multiplied sufficiently and given ade time, could wipe out a continent or revamp on something quite different from its original state. can and do dictate what that little drop wi

can practically dictate the future of a country.
may not be evident, but position is of great impor-
e in understanding a little climate. National inter-
may demand elbowroom and a place in the sun
use of increasing populations or decreasing stra-
resources. We go to war over such matters and
study of how this expansion requirement can be
without destructive changes is of great importance.
our little climates this reaching out horizontally
the necessities of life is often conspicuous. Birds
mammals establish "territories" of their own, which
defend at the risk of their lives. This is often asso-
d with the starting of a new generation and the
ssity of getting food for the young near the nest
en. Men have more or less solved the transporta-
problems so that every city dweller does not need
own cow barn and orchard to survive. Now if we
increase the productivity of every little climate we
reduce our worries about a safe future.
he human population in a large city may be phe-
enal if considered in terms of an acre of the earth's
ace. We now put many in a room in a tenement
make our tenements many stories high. In doing
e change our demands for space on a horizontal
and look to the vertical arrangement.
he vertical arrangement of little climates is common
ature, particularly where extremes are found. A
rt may be too hot to support many forms of life
s surface. But, a few inches or feet underground,
litions may be comfortable so far as temperature,
idity, and other factors are concerned. Conse-
tly, much of the desert animal life goes under-
nd during the heat of the day. Ants may build their
els underground with separate layers at different
hs so that young can be carried to suitable regions.
ven outside, we find that there are temperature dif-
ces at different elevations, which are most impor-
A very few feet up a mountainside may mean
lowering of the temperature.

E speak of the values of "cover" in reference to
the aggregation of loose material, which is usually
mon at the earth's surface, and which forms a
dary between solid earth and air. We recognize a
e series of strata in a forest, from the canopy down
gh underbrush and ground cover to topsoil, subsoil,
bedrock. Each of these strata has its own little
ate or series of little climates and for the most part
wn appropriate populations of plants and animals.
between demands for space on horizontal and
cal axes is a combination of these, which we call
graphical axis or a slope, which is neither horizon-
or vertical alone but a combination of these. Often
graphic distribution of little climates solves many
lems and often it creates many. Think of the im-
ance of slope in your neighborhood and you will
rprised at what comes to mind. Erosion and depo-
of soil. The importance of steepness of slope and
e nature of the surface of a slope, all figure in
rstanding little climates.
sition is of further importance if we consider its
tation to different things—most frequently to the
Living things find different problems if they live
north-facing slope than if they live on a south-facing one. Their day may be reversed in some respects if they live on an east-facing or a west-facing slope. Even the length of the seasons may vary due to this matter of orientation to the sun. Life in a little climate may reach its peak of daily activity in the morning or in the afternoon, depending on the exposure.

Of course, position is important if we think of its orientation with water supply, with transportation facilities such as paths or highways, with food supply, and with sources of danger. Our human communities are growing like wildfire along the routes established by the throughways or superhighways. Orientation of growth of anything is not limited to the position of the sun, as important as that may be in many things. Cottages along a lake shore usually face the water, not the rising sun. Woodchuck dens are placed in or near hedgerows with entrances in or through stumps, roots, or rock piles; and the position of the sun, the slope, or the vertical or horizontal crowding may have little to do with it, though these may affect the story slightly.

WE have neglected to point out so far the factor of stability, which may dictate the nature of a little climate. Neither you nor a deer can "bed-down" comfortably in quicksand. An oriole may find a comfortable nest site at the end of a swinging elm branch but such a place would not please many other animals.

This stability of the immediate environment of a little climate may find its most rugged crises in what happens on a rock that is exposed at low tide. The rock may remain fixed but the environment shifts with each breaking wave and with each change in the tide. The rock can blister in the sun without shelter and an hour later be submerged in a sea water. If we recognize the environment and its inhabitants as making up a little climate then a tidewater rock gives us an ever-changing and a violently changing picture.

If we turn from an exposed rock in tidewater to an exposed rock on a hilltop we may find another and an interesting little climate. The chances are good that the hilltop rock has some spots of lichen growing on it. These lichens make little climates of their own. They are, as you know, a combination of algae and fungi living together with mutual profit. The fungus provides a stable position, which the alga alone could not achieve. The alga can use the sunlight and air to make food, which the fungus must have to live. The fungus may hold some water, which the alga also needs in order to make food. All these factors and others, working together, create a little climate.

THE encouraging part about the study of little climates is that, the more we explore, the greater becomes our confidence that we can *do* something about things over which we never dreamed we could have any influence. The discouraging part is that, while *we* know how to do many things to change little climates on a wholesale basis, we find it difficult to get *other* human beings to do what should be done to the part of the earth's surface that they control.

We know what should be done about controlling wanton soil erosion. We know how such control may be effected, but the proportion of the earth's surface that is wisely managed is decidedly small at present.

	Topographic Position	Air	Water	Sound
CHARACTER	The nature of a little climate may be profoundly influenced by its topographic position, that is, its position in relation to the slope of the solid surface. This may be true on land or under water. This may be more important than position on a horizontal plane or on a vertical axis because slope affects stability considerably. The disturbances owing to the differences caused by slope may be a handicap or may be an asset.	Air is a factor that determines survival of living things in most large and small climates. Air has no definite chemical composition and may include many gases, liquids, and solids, any one of which may affect the character of the air and the associated climate. Air is not essential to the survival of such plants as the anaerobic bacteria, and the multiplication of these of course cannot be controlled by shutting off the air.	Water is essential to most little climates and its management may provide most wanted controls. While water has a definite chemical composition it is an excellent solvent and may be affected by many substances taken into solution. The quantity of water necessary for the survival of plants and animals varies tremendously and some animals are able to get their water supply in association with the digestion of their foods.	It may appea fetched to co sound as an elem any climate, lar small, but this m owing in part to t man's experience sound world is co ably circumscrib his limited facilit giving and rec sounds that are nitely significant t organisms. We hear the sound the hears, the earth make in the lawn echo that guides t in its flight, but v ognize their existe
DIFFERENCES	Slope is generally expressed in percentages. If there is a drop of one foot in every ten feet of horizontal space, the slope is referred to as a ten per cent slope. A slope of one per cent may be of major importance in managing farm land under some conditions. Ability to master the task of going up a slope and to resist the pull of going down a slope are important. We can easily walk up a slope prohibitive to a railroad train.	Hazes, smogs, fogs are caused by particles of liquids or solids or both held in suspension in the air. They may, by shutting off sunlight, greatly affect the nature of climates large and small, particularly where survival conditions are critical. Combustion may remove oxygen from the air and free into it great quantities of carbon dioxide. Smelter wastes discharged into the air, volcanic action, and other phenomena greatly affect its composition.	The particular substances like lime, salt, acids, which may enter into solution in water, may determine the particular values of that water to living things, both in large and in small units. Pure water may be less useful to living things than water with some substances in solution. Pollution of water is a major problem of civilization, as it is coming to be for air, and many communities have to use and re-use their water supply.	Unlike heat and waves, sound wa quire an elastic m for transmissio sympathetic e structures for th ception. The ra sensitivity to waves and of abi produce them is highly limited in ent organisms rarely common t of the population area. Sound wav produce pleasant pleasant sensatio each has its role i ciated animal beh
ADJUSTMENTS	Any substance like a liquid that does not have a fixed shape will, if placed on a slope, tend to change its shape and move downhill. The steepness of the slope will determine the speed of the downhill movement and the ability of the moving substance to carry other substances with it. When the movement is stopped, the load is dropped. Erosion and deposition result from this situation, whether the moving force is water, moving soil, or moving air.	Air in motion changes the nature of climates, large or small. Motion may be necessary and certainly is useful in mixing airs of different composition. Since organisms cannot exist if dependent on their own wastes, such changes as those caused by motion are important. Many animals provide by breathing the necessary motion to change the gases. Some plants and animals store useful air. Others reach it by special periscope-like devices.	Water in motion both solves and prevents the development of problems. From time immemorial streams have been used to flush wastes from congested populations. Violent wave action may upset little climates that may have reached a comfortable equilibrium and eroding streams may change the nature and problems of a spot completely. Management permits useful changes in the position of underground water and may sustain agriculture thereby.	Sounds serve effe in bringing org together to satisf and reproductive and to effect co- tion of large nu of a kind of org They also serve t of the presence mies, of sourc danger in the p world, and to fears that may o not be justified. often have a d psychological effe are used for thes poses. They eve a therapeutic eff times.
EXAMPLES	While valuable topsoil may be lost by the erosion caused by moving water, air, or soil, and values may decrease correspondingly, we know that by management of plant cover and animals topsoil may be built from subsoil at the rate of nearly one-half inch a year. So, proper management of changes that take place on slopes is not only of academic value in understanding little climates, but of strategic value to the wealth of the land.	Air conditioning has become a household word for controlling the climate of a small area in which we can live in comfort. This usually involves both the temperature and the humidity of the air. By management, a degree of control can be effected for many small areas. Tree- and grass-planting, circulation of air and water, the diverting of wind paths on major or minor scales may be a part of the management of air and little climate control.	Distribution of fishes is often definitely governed by temperature and associated climatic conditions. In deep bodies of water there may be three zones placed one above the other, with the middle zone or thermocline bounded above by a layer high in temperature and rich in gases and life and shifting readily, and below by a lower lake poorly populated, often stagnant in summer, and with little circulation.	There is every rea expect that the sound waves in th agement of small will increase a knowledge imp Sounds can be graphed and repro from the photo even to the ext details that cann detected by the ear. We may all into this study by ing what our own ing range ma interpreting o sounds of signi and considering origin and produ

LIGHT	HEAT	PRESSURE	HORIZONTAL POSITION	VERTICAL SPACE AND POSITION
ht and its absence, kness, may be di- ed, controlled, and d as tools of major portance in manage- nt of large or small matic units. Of para- unt importance is the ity of visible light to st in photosynthesis, ich takes place in en plants and forms basic food for all nts and animals. veling at 186,000 es per second its ef- is practically instan- ous.	Heat is a determining factor in the nature of any climate, large or small. Fortunately, heat waves may be directed, created, absorbed, reflected, refracted, and rejected in varying degrees and, so, may be controlled and used for the modification of almost any environment. Temperatures even of large areas may be affected by the management of adjacent areas. Heat may come from the sun or be variously generated.	Whether it is in the air, the water, on the ground surface, or underground, the pressure an environment exerts on the organisms living in it is both a determining factor in their survival and a means of controlling them at times. Air, water, and earthy materials have weight, which may be exerted with telling effects on contact organisms. Many organisms can make minor necessary adjustments.	Horizontal position is sometimes of major importance in determining the success of a little climate. Among the important factors here are distance to food, distance to safety, ability to master horizontal space, distance to peaceful existence, distance to freedom, distance to water, room for expansion in competition with own and associated species, ability to remain fixed if the environment is in motion, as in a river.	Ability to appreciate and to master vertical space can determine the success of a little climate. Roughly the temperature drops about 3° F. for every change of 1,000 feet in elevation. But, in any given area, the temperature differences may be even greater if soil, water, and air are to be found on the vertical scale. Above and below snow crust on a wintery day differences of many degrees may exist in less than an inch.
it may be absorbed dark surfaces, re- ted by transparent stances, and reflected opaque smooth sur- s. It may be broken into the various col- of the spectrum, h of which may vary ts effect on life and each of which or- isms may have speci- reactions, depending ely on the sensitivity special, light-recep- organs, particularly, far as animals are cerned.	There is a close association between light and heat and there may be some association between sound and heat. Important in the understanding and use of heat are the facts that it may be conducted, insulated against, that production of heat may be accompanied by the loss of heat, that heat may be associated with the expansion and contraction of materials and affect the volume and weight per unit of volume of substances.	Changes in pressure may be effected by changes in temperature, exposure to sunlight, composition, position, chemical and physical condition, condition of associated areas, mechanical means and impact. Weather in large or small climates is highly sensitive to pressure differences. For these differences special machines, such as barometers, hydrometers, and other devices, have been developed and are in constant use.	If supporting and consuming agents in a horizontal position in a little climate can change position they may be able to survive. This change may be only minor if food and other necessities are abundant and within reach. A bird in a nest may be able to reach out and get a meal without moving from the nest but a nation may feel called upon to go to war with a neighbor if sufficient elbowroom is not available.	While many plants and animals may become part of great horizontal seasonal migrations, other organisms find equal success by being able to move vertically underground, not only in different seasons, but at different times of the day. This is particularly evident in deserts where great populations of animals live underground during the heat of the day, but above ground in the cool of the night.
mals or plants or r parts may react itively toward ces of light or nega- ly away from them, these reactions may ffected by other fac- such as tempera- , humidity, gravity, so on. Light condi- s in the immediate ronment of an or- ism may be of para- unt importance in rmining its prosper- or survival in larger matic units.	Most organisms have critically high and low temperatures beyond which they cannot survive and these may be used in control or in protection. Temperature is often significant in the feeding, breeding, moving, growth, and maturity of some organisms and its control may be important in the management of organisms so affected. Many animals have constant body temperatures, which must be protected for survival.	The populations of areas are commonly stratified in accordance with variations in pressure and these are particularly evident in air and in water. Each stratum is in a way a little climate with its own physical properties and appropriate populations. Organisms frequently have structural devices appropriate to adjustments to changing pressure, as, witness the air bladder in fishes, special structures in whales, and even some in plants.	Horizontal room requirements vary with the ability of an organism to move about by stretching, crawling, walking, hopping, swimming, or some other means of locomotion. Development of possession of or improvement in the use of organs of locomotion can mark the measure of survival success of a plant or animal. Even plants sprawl wholly or in part over adjacent territory to survive. Some attain similar results by riding other creatures.	Changes in vertical position not only bring rewards through changes in temperature, but they disclose useful differences in water abundance, food abundance, and freedom from disturbance of dangerous neighbors. As was the case in mastery of horizontal space, so, many organisms attain desired conditions in small climates by the extension of parts of their bodies to nearby suitable surroundings.
temperatures above F. cluster flies go ard light and below point they avoid t. Above that tem- ature they avoid con- ; below it, they push inst contact. Know- these facts try to lain the behavior of e common flies on inside and outside of indow during spring autumn. Does your avior in any respect ge on these tempera- s?	Start the practice of mapping an environment and its smaller parts by the use of thermometers to recognize the effect of temperature on populations, on humidity, on hardness. Experiment with insects in thermometer-containing bottles to see what, if any, differences in behavior may be associated with temperature. Note the effect of temperature on the growth of plants and the causes of varying temperatures.	Notice how freezing causes roads, lawns, and other areas to heave, possibly rupturing plants in the process and killing deep-rooted forms unless their parts are pushed back together by the customary spring rolling of the surface. Notice how plants vary in the ability of their young spring growth to resist freezing and how some insects apparently are not affected by the freezing pressures, which so obviously affect others.	Look at almost any horizontal space and notice how in nature it varies and how suitable organisms occupy appropriate space and how successful societies are composed of the various elements needed for survival. Any large or small map shows places where specific things may be found and reasonable planning must be made as populations increase and available horizontal space vanishes.	Where suitable climates of small or large size can be placed serially above each other, the demand for horizontal elbowroom decreases. Skyscrapers in our big cities are supreme examples of how man has used this principle to permit a maximum population to survive in a given and expensive horizontal area. We even park cars one above the other to save the necessity of using horizontal space. Ants and wasps in nests build tiers of living quarters.

	Oriented Position	Underground Climates	States of Matter	Chemical Nature
CHARACTER	Although we recognize the major importance of compass-dictated position, we here elect to include the relationship of little climates to special influences—such as bodies of water, valley winds, and special situations caused by unusual vistas, gorges, parks, and so on. Position in relation to a body of water or periodic wind path may be more important than position in relationship to the sun in determining the nature of a little climate.	Two different worlds exist above and below the ground surface but each may affect the other. Locomotion for plants and animals is relatively limited below ground. Circulation of air and water is not necessarily free. Commonly, there are distinct strata with the humus-laden topsoil being the most important to agriculture and the deepest areas most important to mining and associated geological fields.	The prevailing state of matter in an environment determines in part the large and small climates found there, particularly as these change from one to the other under varying conditions. Ability of an organism to exist as a solid, as a colloid, as a liquid at different stages of its life cycle makes it possible for such an organism to survive when these states of matter are appropriate. They also have significant existence in parts of the physical environment.	Since organisms of make up much of content of little clima areas and since org isms have specific che ical needs, the chemi nature of an envir ment may dictate nature of the little mate. Much of this m be significant if senses are used, ev though critical diff ences may be recogni only by more prec methods. Changes in role of chemistry in affairs have been re lutionary even in li climates.
DIFFERENCES	Other things being equal (which they rarely are), the directness with which the sun's rays strike the ground affects the ground temperature. Obstacles, such as hills, buildings, forests, may reduce the total amount of light striking the ground in a day and reduce the temperature accordingly. Changes of the seasons and time of day and slope of the ground all affect the temperature of a given spot and its little climate as well.	Topsoil is usually composed of rich mixtures of finely fragmented rock, of penetrating plant root systems, of animals large and small, capable of making their way through the soil to a degree and, possibly most important of all, populations of minute animals and plants that work on the soil particles permitting the exposure of new surfaces, renewed oxidation, and eventual enrichment of the soil, and the conversion of subsoil into topsoil.	Early stages of plants, represented by seed, and of some animals, represented by eggs, may be hard and dry and capable of surviving conditions the growing organism could not tolerate. With the addition of water the solid may become colloidal, capable of changing shape and volume, of using food material, and of growth. This may be accompanied by stages where liquids are prominent in food making and transportation, and gases in food consumption.	Conspicuous biologi societies based on che ical differences are marshes, alkali dese peat bogs, and the r sonably informed ar teur may recognize plants and animals as ciated with lime, w sulphur, and other che icals. So significant some of these assoc tions that explorers ev from the air have pr ited by tracing mine veins through observ where pertinent pla have developed.
ADJUSTMENTS	In most of the Northern Hemisphere, for much of the year, the sun never strikes the north side of a post, tree, house, or mountain. Certainly it does not strike there at noon and so wherever there is such a spot it remains a little climate in which organisms dependent on some direct sunlight cannot exist, and it also remains a spot in which organisms that are killed by direct sunlight can exist, unless reflected light is more than adequate.	The work of creatures underground lets in air, water, and organic material. Even the growth of a root may introduce organic material into a place where it had not been. The evaporation of water from the surface of soil calls for replacement by water that is beneath it and this is responsible for some movement of materials from beneath the original water and contributes to a number of valuable changes.	Understanding of little or of large climates demands ability to recognize and to have basic understanding of solids, the gels and sols of colloids, liquids represented by or in solutions, emulsions, and mixtures; solids surrounded by liquids in muds and slimes, floating in a gas as smoke; liquids floating in a gas as a fog and the existence of free gases in liquids as foam. All these are represented in nature and in the techniques used by man in managing nature.	Of course the use chemicals in modify a little climate is wi spread. Lime, fertiliz salt, insecticides, fur cides, oils, all find th place in this mana ment program and carry with their use d gers that are both dir and remote. While fu icides and insectic are almost necessary agriculture, some le residues that are ac mulative and may the long run cause useful area to beco useless.
EXAMPLES	Fortunately, in many cases man will usually place his house so that sunlight falls in a favored room an elected length of time and elected number of days if nothing clocks the sun; and if he seeks to raise grapes, for an example, he can select an exposure where the conditions are right; but often man overlooks these points, which can measure the difference between happy, profitable living and monotonous existence	The burrows of animals provide superior retreats for their builders both in times of severely warm and severely cold weather. Root cellars illustrate one use man makes of the heat-insulating qualities of the earth. The temperature of springs that come from deep in the earth or from shallow sources indicate temperature variations in the earth, which are used for various purposes.	Prepare your own check list of various states of matter. Then apply it to the stages in the life history of any plant or animal to note how each state or combination of states is appropriate for existing in prevailing conditions, or how each may be affected by changing conditions. The very ability or inability of solid plants to use gases, liquids, solutions, and the like may be sufficiently thought-provoking to initiate profitable experiences.	The study of the effe of chemicals on li climates lends itself widespread and pro able experimentati even by amateu Sometimes signific observations have b made based only on cidents. Gasoline spil on a lawn, salt dropp on plants may produ conspicuous results. lution of soil, water, a air by the introducti of wastes from indus and from various m agement-of-soil pract es have grave effects.

LECULAR, MAGNETIC, ECTRICAL INFLUENCES	STABILITY	INDEPENDENCE	SHORT-TIME CYCLES: NOT OVER ONE DAY	LONG-TIME CYCLES: OVER ONE DAY
ough electrical and gnetic influences may great in little cli- tes, it is difficult to ermine which is the st significant. The st spectacular may necessarily be the st significant. We are that many tragic est fires are caused electrical storms but se are relatively un- nmon and infrequent. re important no bt is the role played electrical or mag- tic phenomena in intaining colloids es- tial to life.	Stability is a factor that greatly determines the nature of any large or small climate and of the organisms that live in it. But for the movement of air and water, weather as we know it would not exist. Significant movements may be made by the environment itself or by parts of it, or by organisms in the environment or parts of them, and importance attaches to the degree of movement of each.	As in the physical and biologic fields, it is also safe to say that true independence of little climates does not exist. However independent an animal may seem to be it is dependent on other animals or on plants for food; the plants are dependent on solar energy, water, and other essentials. Similarly, a little climate is dependent on associated climates for its survival. It may take air, water, mineral nutrients and it may take the associate losses.	Time is an element that must be recognized along with chemical and physical differences in little climates. Situations of short duration can be as effective as those requiring a longer time in producing changes. A modern military bomb will produce more changes in a few seconds than the erosion of rock by weather during centuries, and yet each must be recognized.	Planning a program of living for many organisms over a period of time longer than a day, a season, or a year does much to assure desired developments, and may be as important as the development of superior structures associated with living. Spectacular rewards have come from understandings that have led to hastening the maturity of domestic plants and animals through environment management and, subsequently, extending the life span of man.
whole physiological cess is dependent gely on the existence functioning of col- ls, solutions, emul- ns, and similar states matter in which in- tesimally small units essential materials commonly held in pension in liquids in h a form that they y be used easily and iously. More spectac- r of course is the harge of electrical rgy in a thunder- m which may in- ve friction caused by ving air.	Changes in position may be effected by the influence of outside forces, as the moon affects the tides, which involve motions that determine many of the problems of survival of influenced organisms. Similarly wind, shifty earth, and moving animals and plants must be considered. The little climates of a game trail may vary greatly from those of adjacent territory, and the ability of plants and animals to survive impact on a beach or a lawn may be important.	Biologists recognize symbiotic relationships in which two or more organisms are mutually dependent with no loss to either; parasitism in which one organism lives solely on the loss of the other; saprophytism, in which an organism exists on the dead bodies or wastes of another, and commensalism, in which organisms may be dependent on one or more others without destruction of the host. Similar relationships exist between little climates.	Some specific, significant short-time sequences might involve the following; respiration and ability to survive without it, the length of time an organism can survive intense heat, great physical pressure, or extreme cold and low barometric pressure such as are to be found at high altitudes. Important also is the percentage of an organism's body that may be adversely affected without critical results. Ability to survive desiccation is important.	Some of the long-time span areas in which we have made progress, but can make much more, are the time necessary to restore exhausted soils to productive capacity, the time required and the food needed to develop individual animals to maximum usefulness, the time necessary to restore to production burned-over forest lands or destructively flooded lands, the time required to bring a flock of hens, an orchard, or a fish pond to produce at maximum.
may seem a bit ex- ne to note it, but the ldozer and power m machinery are king and eliminating re little climates each than ever before. se machines are, to sure, powered by ls but their function- involves the wise of electrical energy their electrical sys- ns. Eliminate this n modern industry agriculture and we uld be forced of ne- sity to let nature take r the making and use little climates.	While many organisms move freely with their immediate environment, some have parts that remain fixed, others move about or maintain a root system in an area favorable for those plant parts, but the stems and leaves have freedom to shift to areas where the needs of these parts may be better met. These plants may be living in two little climates at the same time, one stable and the other unstable.	If we recognize as elements of climate or weather the units mentioned, we must recognize how closely any one is associated with another. Change in temperature causes change in pressure, due to change in volume, and this may automatically cause a change in humidity. These changes may vary with their orientation with the sun, with the air, and with the changes that take place in the immediate vertical or horizontal neighborhood.	The sensitivity of organisms and of parts of organisms to harmful or helpful influences for short periods of time can be highly important. Under what condition, for example, can the root hairs of a plant remain exposed without their destruction, and for how long? Values exist and can be recognized in the establishment of habits of eating, resting, and working that may influence the success of a variety of organisms in little climates.	Increased knowledge of genetics has provided a maximum of help in improving our mastery of long-time problems of plants and animals. We have changed the breeding period of plants and animals, have learned how to produce them so that they will grow in what may have been unsuitable soil, how to be sure that the offspring will arrive when they may be most efficiently brought through critical times of the year, and be disease-resistant.
H. Bailey in his verse “Mother Mud” al- es to the importance he situation when he tes, “And ev’ry bird hoof and bud in ily part and sacred n proclaim the kin- p of the mud.”	Try to interpret in the nature of different little climates the appropriateness of the movements of animals, or plants, or their parts. A flower turns toward the sun, a part of an apple tree is pruned making conditions different for adjacent parts and permitting improved prosperity to the plant as a whole and to its owner. The ramifications of this whole situation should be sufficiently challenging for a long-sustained exploration.	In terms of their effect on little climates, consider the everyday things we do in which the immediate and most important thing done is to control the climatic condition in the immediate environment of a living thing. Notice how agriculture, medicine, dentistry, and even industry are dependent on little climates that are associated with them.	Ability to react quickly to changing conditions is rewarded promptly by victory in athletic events and through practice may be improved. Many organisms that cannot react promptly to new situations find themselves destroyed. Much effort is spent in training organisms to perform certain functions in a minimum of time to the end that maintenance costs are reduced and profits forthcoming.	Ability to predict with reasonable accuracy situations that may be expected to develop biologically, geologically, and statistically offers great rewards for intelligent behavior. Forestry, agriculture, medicine, animal husbandry have shown phenomenal improvement over long periods of time.

nature IN THE SCHOOL

THIS study of little climates should be useful in school for the phenomena with which it is concerned may be created in any schoolroom at any time with the simplest of equipment. Yet these simple experiments point out principles that are involved in the whole field of study concerning organisms in relation to their environment. We can do little about the climate of Africa, of Patagonia, or of Arkansas. We can, however, create in a couple of fruit jars conditions of temperature, light, humidity, and the like that simulate conditions to be found almost anywhere in the world at any time of the year. We can with a simple twist of a bottle turn night into day, winter into summer, wet weather to dry. We can put animals and plants into these little climates and observe how they respond. Through these activities we may well gain a better understanding of large and small climates than we could through the reading of many books or attendance at many lectures. Here's how.

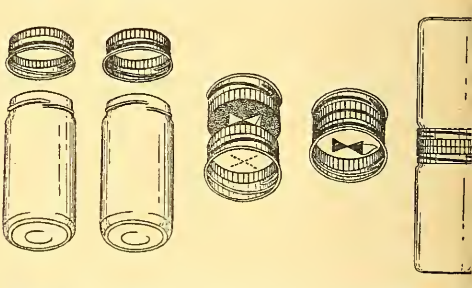
Take two metal-topped jars. Remove the tops and place the tops back to back. With a strong knife or tinsnips, cut a cross in one of the tops (*illustration*). Using this cross as a guide, mark an identical cross in the other top. Cut this cross, also, and place the two tops so that the free portions of the cross coincide. Push two opposite angles of the cross one way and the other two angles in the opposite direction so that the two tops are locked firmly together back to back. Put the bottles back on the locked tops. This equipment is all that is really needed to do the basic work of climate study.

If you cover one of the bottles with a piece of black cloth, you have one bottle in which night conditions are simulated. The other may have conditions of the day. Put some free fruit flies or cluster flies in either one of these bottles to see if they prefer conditions of light or of darkness. Can you, by controlling the light, control the behavior of the flies? If you can control the behavior of the flies in the bottles, what can you do to influence their behavior outside? Knowing what these flies do in response to light, figure out how you can use light to move the flies from one room to another. Try out your ideas to see if they work. If they do not, then try again with some changes that may occur to you. Read the column on "Light" in the chart section (*see* p. 37), and you may get a suggestion.

If you wish to see what effect temperature may have on the behavior of flies in your little climate, then raise the temperature in one bottle and lower it in the other. An easy way to raise temperature is to fill a hot water bottle with warm water and place it on one bottle. By putting cold water in another hot water bottle and putting this on the other bottle you can get a cold climate. Now fool with these climates and the flies to learn what you can from what you see. You might try placing a hot bottle on top of your experimental bottle and a cold one beneath it to see if the flies show any preference. Using light and temperature—or either—can you get all of the flies to move into one bottle?

It may be worth your while to see between which temperatures your flies are active. Certainly, you can make it too cold or too hot for them. After you have decided—through your bottle experiments—what te peratures your flies prefer, keep watch outside the bot to see if the flies behave the same way outside as th did inside. You may wish to try any of the insects y can find on a schoolroom window to see what temper ture ranges they prefer. Try wasps, cluster flies, lar bluebottle flies, or ordinary houseflies. You will sure notice some differences in the responses of these insec

If you wish to use your bottles to experiment wi humidity, put a small wad of wet tissue paper in o of the bottles. Beneath it, one the outside, place a h water bottle filled with hot water. Over the top place hot water bottle filled with cold water. After a while, y will noice that a cloud of vapor forms inside the bott Is this vapor near the source of cold or near the sour of heat? Reverse the positions of the hot water bottl to see if you can make the vapor form on the low or on the upper side of the experimental bottle. T to explain what you see.



HAVING LEARNED a bit about experimenting wi living animals—such as flies—try your luck wi other animals. A wood frog may change its col within an hour if it is put in darkness. Put one of the frogs in a darkened bottle and another in a light bottle and leave the two for an hour. When they a put side by side what color differences can you not You might like trying to cover just the eyes of yo frog—to see if the color change is due to the light which the eyes are exposed. What do you conclude?

If a fly hangs around the bald head of a person in lighted room in the evening, why do you suppose seeks the head rather than a dark part of the roon If you wish to swat the fly why not illuminate son light area like a refrigerator door to which the fly m go, using a flashlight to pinpoint the spot? You m be surprised to find that the fly obligingly goes to t place where you want it. It may then be controlled whatever means you prefer. The best part of it is th you have done this by learning how to control t behavior of a living thing.

These simple experiments, and those that they m inspire, will help you learn much about living thin and little climates. The experimental materials nee cost you little. The animals for the most part come you whether you want them or not. You need neith kill nor harm your experimental animals. Yet what y learn can be useful in many ways.

DR. E. LAURENCE PALMER, for many years director of NATURE MAGAZINE's educational program, continues his special inserts in the pages of the combined magazines.

ky
eporter

y SIMONE DARO GOSSNER

OMIC FURNACES are old hat in the universe. If light and heat were rated in the stars by ordinary bustion, there would not be igh material in these bodies to the fire going for very long. The ear reactions to which stars owe energy are similar to those in a ogen bomb, the only important rence being that, in stars, the re- ns occur at a much slower rate, out explosion. The fundamental ciple involved in all this is the sformation of matter into energy rding to Einstein's most famous tion ($e = mc^2$). Conditions of erature and pressure prevailing in each star determine in general manner in which the release of gy is accomplished. Two such esses are thought to be prevalent: imple *proton-proton reaction* and nore complex *carbon cycle.*

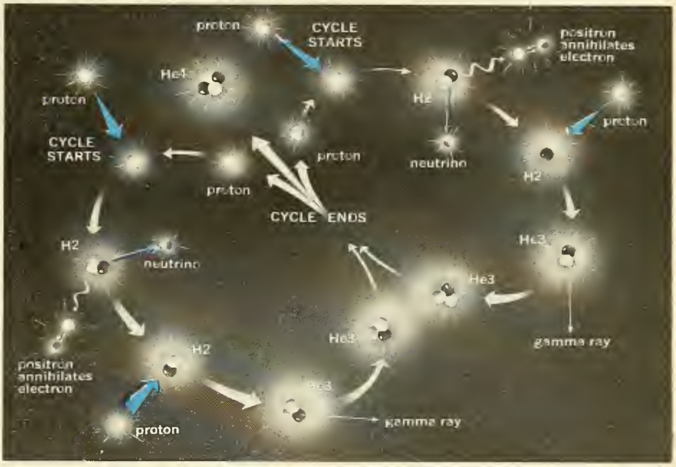
the first step of a proton-proton ion, the nuclei of two hydrogen s (protons) collide to form a eron (H2). This fusion is accom- ed by the release of one positron ne neutrino. The positron eventu- annihilates a free electron to pro- a quantum of energy. The neu- escapes into space and is lost to tar. The second step sees the deu- combining with another proton rm an isotope of helium (He3). ma radiation is emitted at this t. Finally, the fusion of two such nuclei produces one nucleus of ial helium (He4) and two pro- which are available for a repe- of the whole process. The net t of the reaction is the transfor- on of four protons and two elec- s into one normal helium nucleus, quanta of energy, two neutrinos, gamma radiation.

HE carbon cycle is a similar chain of reactions involving the fusion otons with the nuclei of heavier s of carbon, nitrogen, and oxygen diagram, *right*). The successful pletion of the cycle assumes the spontaneous transformation of nitrogen N13 and oxygen O15 into the more stable carbon C13 and nitrogen N15, respectively. It may be noted from the diagram that the carbon cycle has the same net result as the proton-proton reaction. Carbon C12 acts only as a catalyst in the nuclear transformation: it emerges in its original form at the end of the cycle and may serve again and again in the same catalytic capacity.

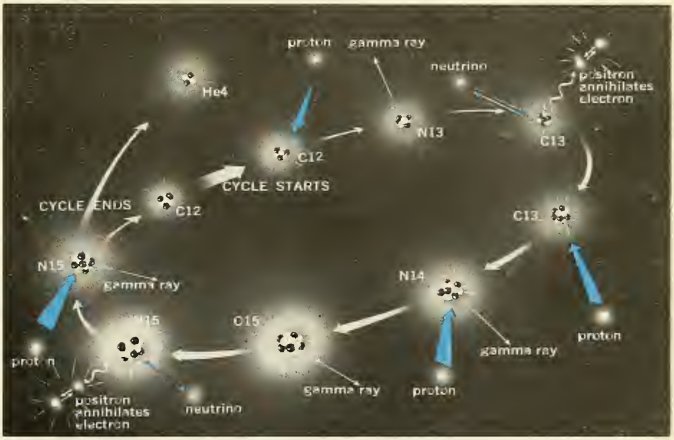
The carbon cycle requires higher temperatures than the proton-proton reaction. The generation of energy within a given star will therefore depend on the prevailing temperature conditions. Our own sun, however, constitutes a borderline case, where both these processes are present.

The transformation of hydrogen into helium occurs at an extremely slow rate. For example, it is estimated that our sun has consumed thus far only five per cent of its hydrogen supply. On the other hand, it is evident that aging stars will tend to become poor in hydrogen (but rich in helium!). Yet such stars still shine brilliantly. One must assume that they derive their energy from some other "fuel."

In 1954, the British astrophysicist Fred Hoyle suggested that helium nuclei themselves might serve as building blocks for heavier elements, with the attendant generation of


proton
CYCLE STARTS
positron annihilates electron
He4
proton
H2
proton
CYCLE STARTS
proton
neutrino
proton
H2
CYCLE ENDS
H2
neutrino
He3
He3
He3
gamma ray
positron annihilates electron
H2
He3
proton
gamma ray

LOW-TEMPERATURE FURNACE is outlined, *above.* Cycle starts and ends, *center,* as fusion of two He3 nuclei forms one nucleus of He4, releasing two protons.


proton
gamma ray
neutrino
positron annihilates electron
He4
N13
C13
C12
CYCLE STARTS
CYCLE ENDS
C12
C13
N15
gamma ray
N14
N15
O15
proton
proton
gamma ray
positron annihilates electron
neutrino
gamma ray
proton

HIGH-TEMPERATURE FURNACE involves a catalyst, C12, in a complex sequence, but net result is same: transformation of the lost mass into radiant energy.

energy. According to Hoyle's theory, three He4 nuclei would combine to form carbon C12, with emission of gamma radiation. Similarly, the fusion of this carbon with another nucleus of helium would produce oxygen O16 with gamma radiation, and so forth. Until recently, Hoyle's theories were considered with skepticism because the helium reactions could not be produced in the laboratory. In 1959, however, D. E. Alburger, of the Brookhaven National Laboratory, attacked the problem anew with special equipment, designed by himself, and with the powerful Van de Graaf accelerator at Oak Ridge. Not only did he succeed in fusing helium into carbon, but precise measurements of the quantity of energy released in the reaction agreed exactly with the amount predicted by Hoyle's theory of helium nucleus building blocks.

THE SKY IN MARCH

From the Almanac:

Moon at first quarter:	March 5, 6:06 A.M., EST
Full Moon:	March 13, 3:26 A.M., EST
Moon at last quarter:	March 20, 1:41 A.M., EST
New Moon:	March 27, 2:38 A.M., EST

The sun will be at the vernal equinox on March 20, at 9:43 A.M., Eastern Standard Time. This will mark the beginning of spring in the Northern Hemisphere.

For the visual observer:

With the exception of Mercury (March 1 to 10), all planets will be found in the morning sky.

On March 1, Mercury will set in the west about ninety minutes after sunset. It will be in inferior conjunction on March 10, entering the morning sky on that date. By the end of March, it will rise about an hour before the sun and will be low over the eastern horizon at sunrise.

Venus (magnitude −3.3) will rise in the morning twilight, about an hour and a quarter before sunrise on March 1, an hour before sunrise on March 15, and forty-five minutes before sunrise on March 31. It will be low in the east at dawn.

Mars (magnitude +1.4) will rise approximately ninety minutes before the sun throughout the month of March. It will appear low in the southeastern sky at sunrise.

Jupiter (magnitude −1.7) will be located in Sagittarius. It will rise at about 2:45 A.M., local time, on March 1; 1:45 A.M. on March 15, and 12:45 A.M. on March 31.

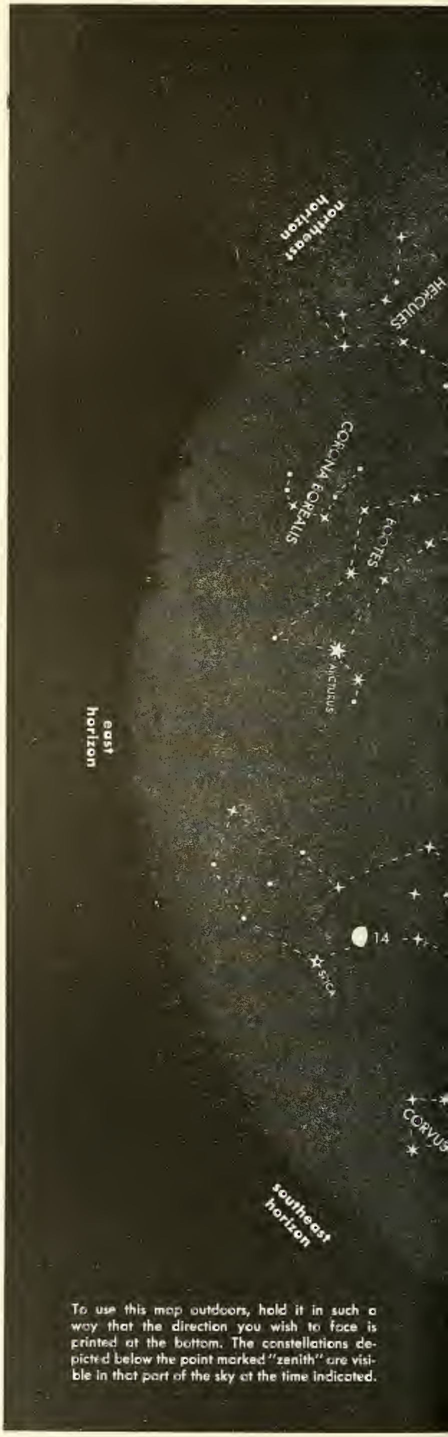
Saturn (magnitude +0.8) also will be found in Sagittarius, trailing behind Jupiter by approximately an hour and a quarter. Thus it will rise at about 4 A.M. on March 1, 3 A.M. on March 15, and 2 A.M. on March 31.

Eclipses

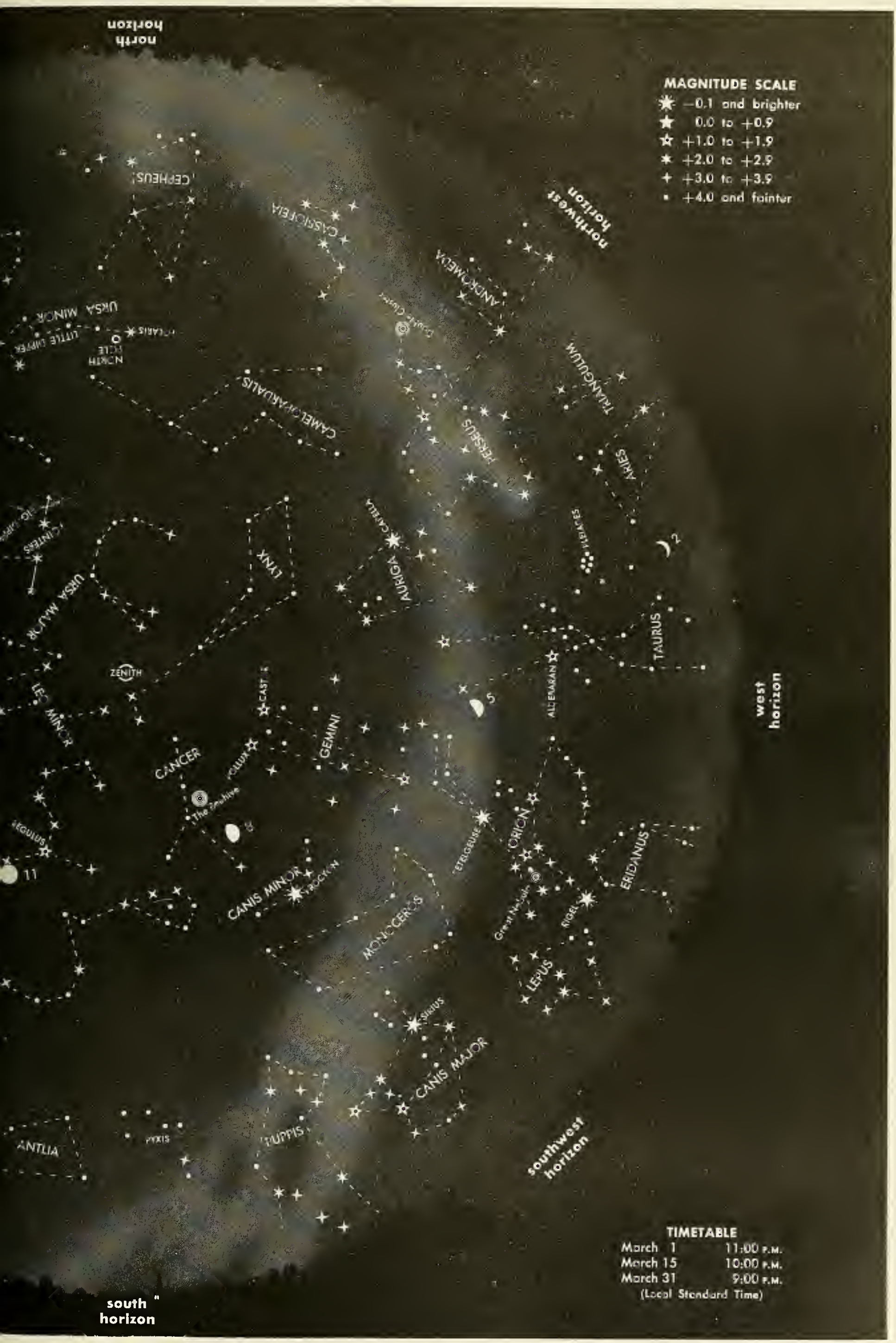
A total lunar eclipse will occur during the night of March 12-13. The entire phenomenon will be visible from the United States, beginning at 1:38 A.M., EST and ending at 5:18 A.M., EST. The total phase will last from 2:41 to 4:16 A.M., EST with mid-totality at 3:29 A.M., EST.

There will be a partial eclipse of the sun on March 27, but the phenomenon will be limited to parts of Antarctica, southern Australia, and the south Pacific Ocean.

The former Astronomy Editor for NATURE Magazine, Mrs. COSSNER, continues in that role for NATURAL HISTORY.



To use this map outdoors, hold it in such a way that the direction you wish to face is printed at the bottom. The constellations depicted below the point marked "zenith" are visible in that part of the sky at the time indicated.


north horizon
CEPHEUS
CASSIOPEIA
northwest horizon
ANDROMEDA
URSA MINOR
LITTLE DIPPER
POLARIS
NORTH POLE
Double Cluster
TRIANGULUM
CAMELOPARDALIS
PERSEUS
ARIES
CANES VENATICI
PLEIADES
2
CAPELLA
URSA MAJOR
LYNX
AURIGA
TAURUS
ZENITH
ALDEBARAN
west horizon
LEO MINOR
CASTOR
5
GEMINI
CANCER
POLLUX
The Beehive
8
REGULUS
BETELGEUSE
ORION
ERIDANUS
11
CANIS MINOR
PROCYON
Great Nebula
RIGEL
MONOCEROS
LEPUS
SIRIUS
CANIS MAJOR
ANTLIA
PYXIS
PUPPIS
southwest horizon
south horizon

MAGNITUDE SCALE

✸	−0.1 and brighter
★	0.0 to +0.9
☆	+1.0 to +1.9
✶	+2.0 to +2.9
+	+3.0 to +3.9
•	+4.0 and fainter

TIMETABLE

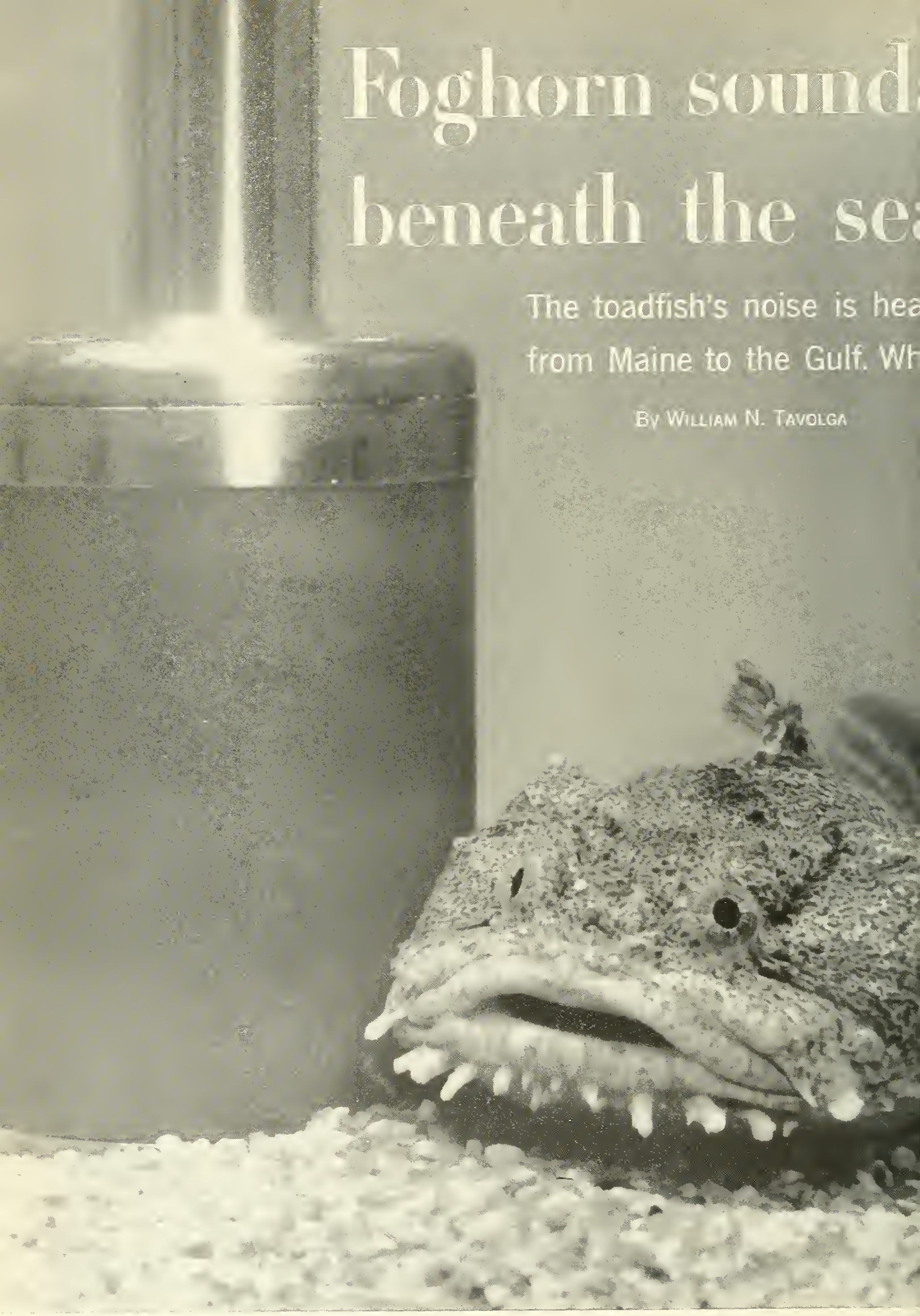
March 1	11:00 P.M.
March 15	10:00 P.M.
March 31	9:00 P.M.

(Local Standard Time)

Foghorn sound
beneath the se

The toadfish's noise is hea
from Maine to the Gulf. Wh

By William N. Tavolga



HYDROPHONE — special microphone used in the author's research—is lowered over rowboat's side as a recording of toadfish sounds begins.

FISH in aquarium shares tank with phone—both seen ize. This species *psanus tau,* called tlantic toadfish.

A PEACEFUL NIGHT almost any- where along the shore line, shal- or estuaries of our Atlantic , one is likely to hear occasional sounds, rather like the foghorns -off boats. These sounds do not ate from boats at all, but from ommon toadfish, *Opsanus tau.* ugly, ill-tempered animal is well n to fishermen, who often hook it d of more palatable game. The gamy flesh of the toadfish is not lered edible; it will swallow a l hook completely and sometimes the sinker too; it bears sharp s, capable of inflicting a painful d; its large, toadlike mouth has of short, stout, sharp teeth. All , *Opsanus tau* is an unpleasant ner and a nuisance to sportsmen. considerable interest to science, ver, is the toadfish's ability to its foghorn-like "boop." The ls produced by the submerged re loud enough to be heard out ter but underwater, if one is enough, the blast can be almost ing. Measurements have shown at a distance of two feet, the output of a single toadfish may an intensity of over 100 decibels, e comparable to the noise of a g machine or a subway train. is close range, the toadfish's are painful to the ear. But sound rapidly underwater; at a dis- of ten feet or more, the boops a far-off quality.

The toadfish, of course, is not the only noisemaker in the sea—it just happens to be one of the loudest and most distinctive. The concept of the "silent deep," as we have discovered in the past decades, is a false one. Even a skin diver with no special listening equipment will hear a constant background noise—crackling, grunting, scraping, and thumping—as he travels underwater. The commonest marine noisemakers are species of small, inedible shrimp. These animals, which hide inside empty shells, in crevices, or under rocks, possess a claw with a special snapping joint. The cumulative impact of thousands of these little claws at work is a steady din, like the crackle of static. Both crustaceans and fishes who feed upon the organisms that encrust rocks and pilings add to the submarine bedlam as they scrape and pick at their prey with claws or teeth. Rapid movements and changes of direction among large predatory fishes, such as barracuda, produce a sound like that of a dropped bowling ball. During the spawning season, schools of drum or weakfish will sound like an orchestra of bongos, while a large aggregration of sea catfish will bubble like some Brobdingnagian coffee percolator.

Shallow coastal waters are usually noisier than the deeps, and this is probably a function of a larger number of secretive species that hide and stake out territories among rocks and other shelters. The deeper regions tend to be quieter, but there is less known of the benthonic sound-makers there. Dr. Donald R. Griffin, of Harvard University, recorded some mysterious echoing wails at a depth of over 2,500 fathoms, but he was not able to identify the source of the sound.

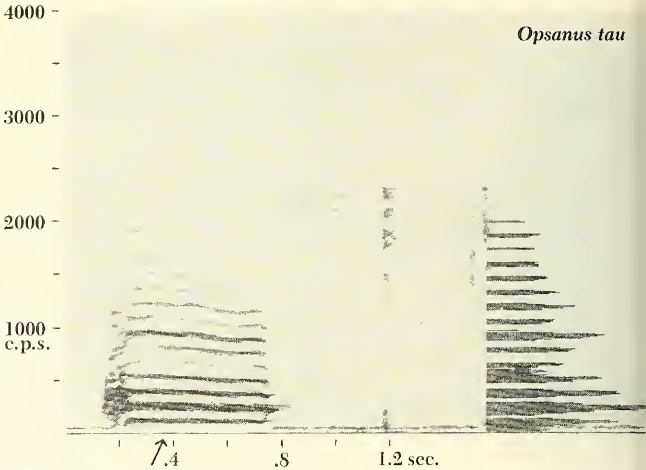
DESPITE this tumult, adequate detection of underwater sounds is no simple matter. Any ordinary microphone can be waterproofed, but most still require a cushion of air around the pressure-sensitive element and this buffer stage makes the rendition of water-borne sounds inaccurate. Special, submersible microphones—called hydrophones—must be used, together with amplifying equipment that matches the electronic characteristics of both the hydrophone and the recorder that receives the signal. Since World War II, equipment has been developed to the point where underwater sounds of biological origin can be studied adequately.

Following the invention of sonar, an underwater sound system that can be used to locate submerged objects much the way radar is used above water, the U.S. Navy has been concerned with the problem of the noise produced by the whole range of marine animals. To the biologist, however, these sounds are not noise in the sense of interference. Rather, the study of such sounds gives us an insight into many hitherto unknown facets of animal behavior. We now know that the sense of hearing and the production of sounds may be just as important in the lives of aquatic animals as are the senses of vision and smell.

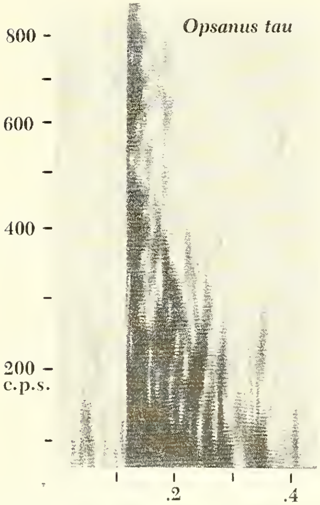
In the case of the porpoise, and probably other cetaceans as well, for example, W. N. Kellogg of Florida State University, at Tallahassee, has demonstrated that echolocation is almost essential to orientation and the location of food. For many fishes, sound production is known to be related to spawning activity: this is true for the drum, the croakers, and others, particularly the goby (see NATURAL HISTORY, March, 1958). The male goby, for example, emits soft, low-pitched grunts in the course of its elaborate courtship. In the majority of cases in which sound production has been detected, however, little is known of the exact conditions under which sounds are made and of the possible role of these sounds in the normal behavior pattern of the species.

THE loud, distinctive calls of the toadfish make this species a potentially fruitful one for study. Two questions immediately present themselves: how does the toadfish make these sounds, and why?

Before we answer the first question, we must describe the sounds of the toadfish in some detail. Two distinct kinds can be detected: the powerful, foghorn "boops," mentioned earlier, and short "grunts," sometimes accompanied by a long, deep-throated "growl." To describe sounds as boops, grunts, or growls is, of course, to be both subjective and inaccurate. Each reader will form his own impression of what these words represent. Recording the sounds is obviously the best descriptive method.



ATLANTIC TOADFISH's "foghorn" sound is graphed twice here. Fundamental at 140 c.p.s. is seen at left: majori of energy in lower register, at rig



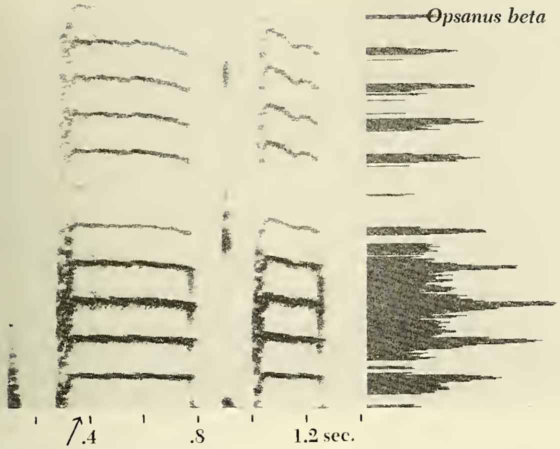
RECORDED GRUNT of Atlantic toadfish shows this sound's unmusical quality.

Records of many animal sounds, especially bird songs, are available but little has been done to use actual illustrations of sounds to accompany a text in a manner analogous to diagrams. Yet we can analyze sounds and illustrate the results of our analysis in objective terms by use of an instrument known as the sound spectrograph. Use of this device in connection with the mating calls of frogs and toads should be familiar to the readers of these pages (see NATURAL HISTORY, April, 1958). The machine does to sound what a spectroscope does to light: it breaks up a complex combination of vibrations into its various component frequencies.

In sound, pitch is a function of the frequency of vibration: thus middle C has a frequency of 262 cycles per second, the A above is 440 c.p.s., and so forth. Most natural sounds are composed of many frequencies—that is, harmonics—at regular intervals above the fundamental, or lowest, frequency. Various combinations of frequencies are what are primarily responsible for differences in quality, or timbre—for example, the evide contrast between a violin, a hum voice, a trumpet, or a frog's croak.

The sound spectrograph separat a given sound into these compone frequencies and automatically mak a written record that plots the ha monics horizontally (see illustratio left and right, *above*). The height each trace above the base line is measure of its frequency in c.p.s.: t length of each trace is a measure the sound's duration in time. In second type of record possible wi the sound spectrograph, the relati loudness of all the component fr quencies can be measured. The i strument, furthermore, detects an presents in a graphic manner prope ties of sound that cannot be heard measured by the human ear. In ma ways, therefore, a spectrogram even more useful for descriptive pu poses than is a recording.

A SPECTROGRAM of a toadfish's ty cal boop shows that the ma portion of this sound consists of dark stripe at the level of 140 c.p. or almost D below middle C, *abo* Additional stripes above the fund mental represent harmonics. The are distributed at 140 c.p.s. interva up to almost 2000 c.p.s.—a note w above high C on the musical sca The length of each trace in the l portions of the illustrations, *abo* represents a time interval of sligh less than six-tenths of a second.



OAST TOADFISH's "foghorn" is a
sound, with its fundamental up around 350 c.p.s., harmonics up nearly to 4,000 cycles, bulk of energy higher.

relative amplitude, or loud-
or each of these harmonics can
wn in a second sort of record,
uency-amplitude graph (at right
trations, *above*). From this, one
e that the fundamental fre-
and the next harmonic repre-
major portion of the total
in the boop.

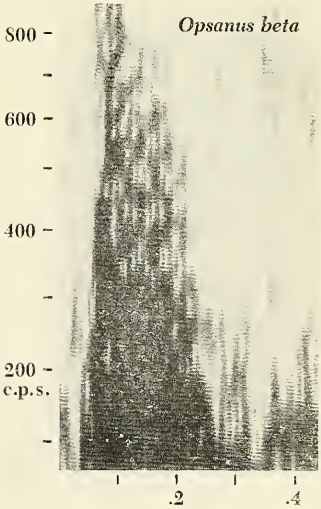
oop spectrogram also shows a
prelude to the full sound in the
of a series of short markings.
ear, this prelude resembles a
ched grunt. This is the toad-
second noise, and such grunts
occur without a following boop.
grams of the grunt, (left and
below) show it to possess a
lower fundamental frequency,
100 c.p.s., than the boop. Har-
s in the grunt are so numerous
closely spaced that it is im-
e to separate them. Here, then,
n contrast an essentially non-
l sound with one that has some
l quality to it. A spectrogram
human speaking voice is not
that of the toadfish's grunt,
gh the human voice is higher.
he course of this investigation,
npared the boop sounds of the
on Atlantic toadfish, *Opsanus*
ith those of its close relative
the Gulf of Mexico, *Opsanus*
The latter species is a bit smal-
d lighter in color than *O. tau*,
herwise similar in appearance
habits. Its boop, however, is
different: *O. beta* habitually emits a double boop, the second one shorter than the first. Each of the boops is preceded by a short grunt and the entire performance is preluded by a longer grunt, as if it were a warmup. Verbally, we might represent the sound sequence as : "grunt, bu-boooop, bu-boop."

THE boop of the Gulf Coast toadfish also differs from that of its Atlantic relative in additional ways. *O. beta's* fundamental frequency is 350 c.p.s., or more than an octave higher. Harmonics are present, at 350 c.p.s. intervals, up to 3,850 c.p.s. The relative amplitudes of these harmonics are also characteristic. Usually the harmonic at 1,050 c.p.s. is strongest with the one just below, at 700 c.p.s., almost equivalent. The top harmonic, at 3,850 c.p.s., is usually weak and sometimes absent. Even without measuring the specific frequencies involved, a comparison of spectrograms of the sounds of the two species shows the differences clearly, as the illustrations above indicate. To the ear, the two sounds are also easily separable.

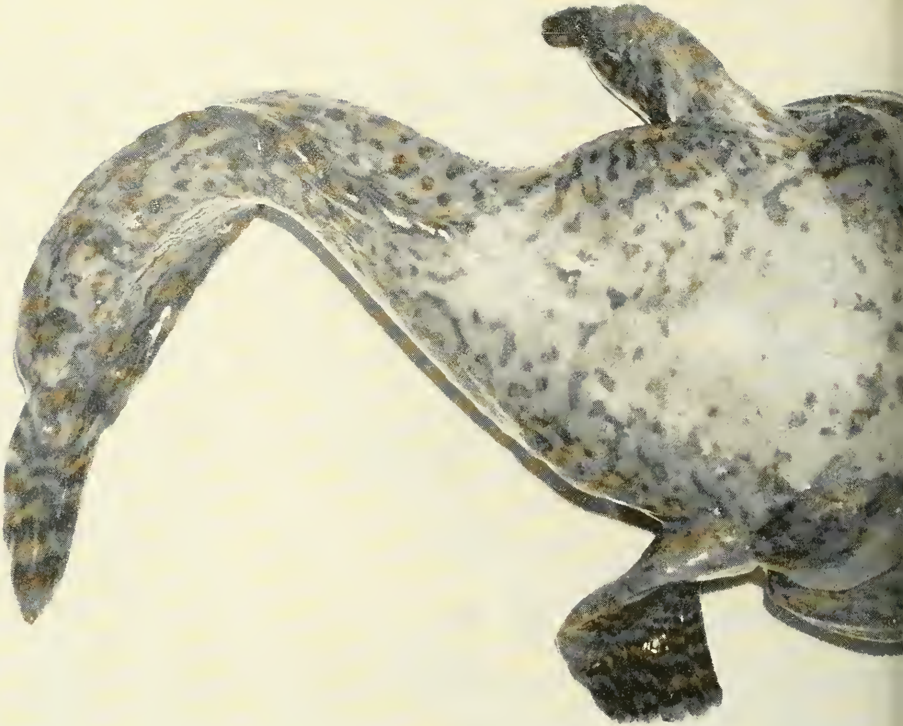
How does the toadfish make these sounds? Lacking a set of lungs and vocal cords, what sort of mechanism does he use? Basically, the sound-producer is its air bladder, an organ present in most fishes as a stabilizer that permits the animal to maintain its position at various depths. The content of a fish's air bladder can be varied, by most species, either through a connecting tube opening into the esophagus or by the alternate secretion or absorption of air by surrounding blood vessels. In the latter case, there are usually found complex interwoven masses of capillaries —known as "red glands"—which possess the necessary large surface area for rapid gaseous exchange between blood and air bladder.

In the majority of fishes capable of sound production, it is the air bladder that is used—in the manner of a drum. The air within the bladder is set in vibration by pounding upon it or moving the bladder's surface in some other way. In the case of the toadfishes, however, the air bladder, in itself, is a complete, self-contained sound-producing system.

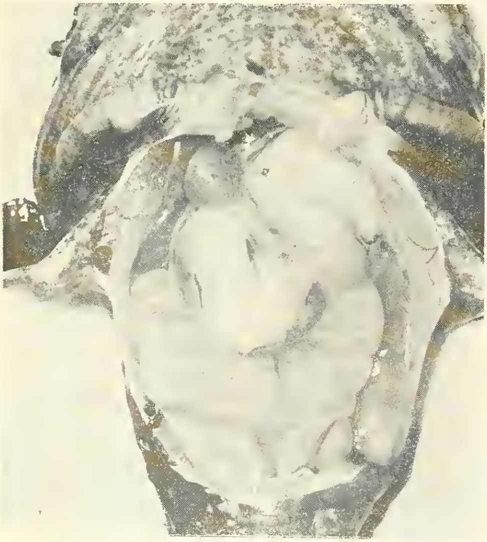
The toadfish air bladder is large, heart-shaped, and loosely attached to the dorsal part of the abdominal wall. Along its sides lie a pair of broad, flat muscles. Vibration of these muscles sets the enclosed air in motion. Within, the bladder is divided in two chambers by a thin, membranous partition. There is no connection to the esophagus: some small "red glands" lie along the ventral margin of the partition membrane. This membrane has a tiny hole in its center, with a circle of muscles around it. Stimulation of the nerves leading to a toadfish bladder that has been completely removed from the body will result in



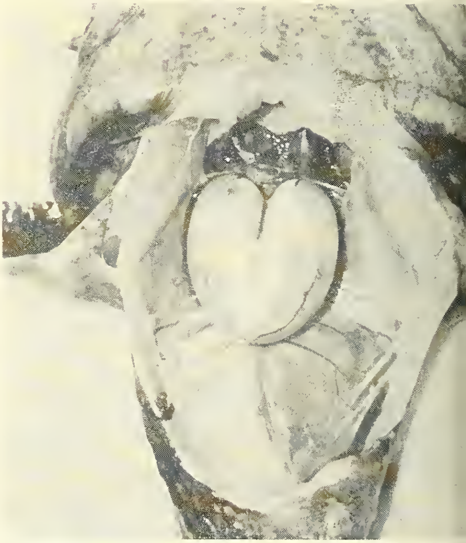
GULF SPECIES' GRUNT is very similar to Atlantic sound, equally unharmonic.



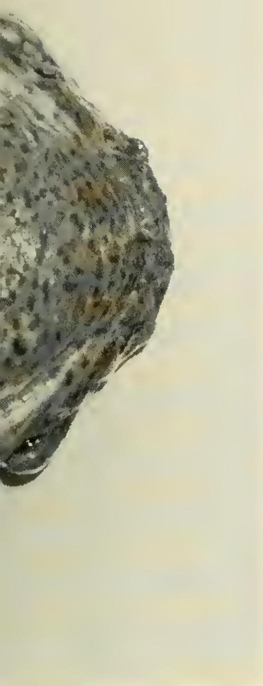
Ready for dissection, a specimen of the Atlantic toadfish lies, belly up and gills agape, in the author's laboratory.

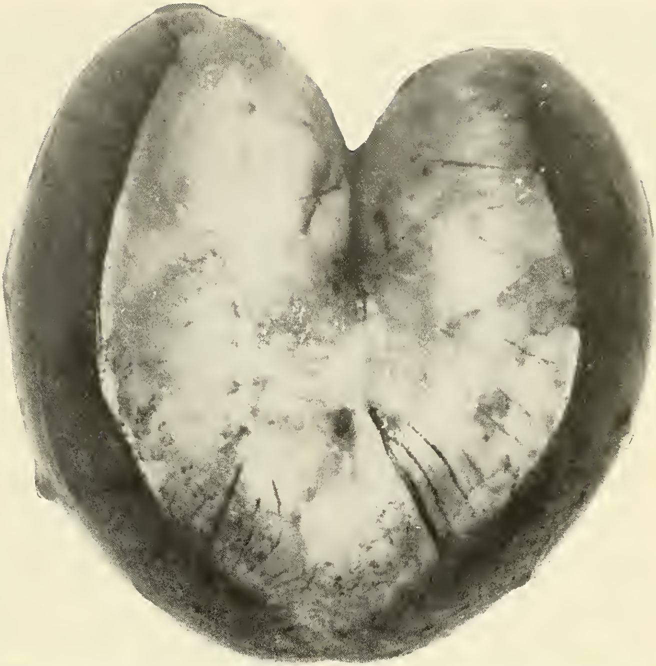


Abdominal cavity open, the swim bladder—"voice" organ of the toadfish—is now visible beneath tangle of viscera.



Exposed swim bladder, a heart-shaped organ, is literal a balloon of thin tissue, puffed up by the air it contain

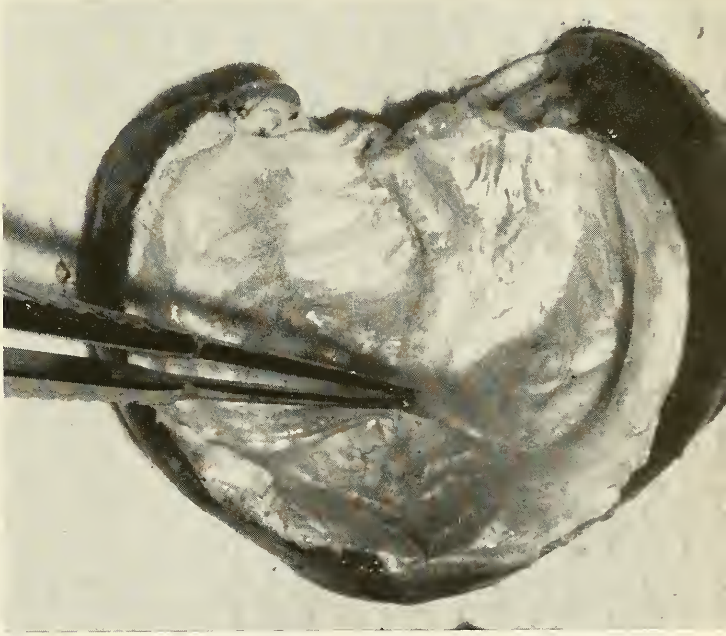




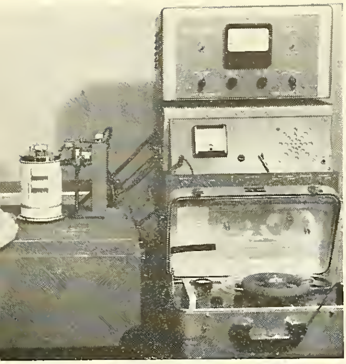
Bladder's surface, shown in close-up, carries a band of muscle along outer curve. Vibration of these muscles is what sets the contained air in motion.

roduction of gruntlike sounds.
nplete boop sound complex has
be elicited by this procedure.

E precise mechanism of sound
roduction is not known. It has
theorized that the hole in the
ion is a valve that is normally
closed and that the muscle-in-
vibration of air in the two
bers sets the partition in motion.
ize of the chambers and the ten-
of the partition would determine
ndamental pitch of the sound.
hapes of the chambers, in turn,
determine the sound's timbre,
monic content.
might logically ask: can the
sh hear the sounds of other
sh or, indeed, can he hear any-
at all? Actually, fishes in gen-
have excellent hearing. Many
species have shown an auditory
tivity greater than humans'.
discrimination is remarkable in
species. The common goldfish,



Opened bladder shows thin partition (grasped in forceps), which divides the interior. This membrane is a sort of drumhead, reacting to air's vibration.



Playback of recorded toadfish sounds is converted to graph by this machine.

for example, can be taught to discriminate between half tones and can remember a scale containing as many as eight different notes.

Fishes with air bladders have better hearing than those without. This means that the air bladder in some way enhances the auditory sense. Since a fish lives in water, its body fluids and protoplasmic contents are actually only slightly different in density from its surrounding medium. In a sense, a fish is "transparent" to water-borne sound, and the presence of an air bladder serves as an acoustical discontinuity within which sounds can be reverberated and amplified. In some fishes—the catfishes, for example—there is a series of small bones connecting the air bladder to the inner ear. This apparatus acts in a manner analogous to the bones of the human middle ear in transmitting the sounds to the vibration-sensitive nerve endings through the fluids of the inner ear. Although the toadfish has not been specifically tested for its hearing acuity, from the evidence on many other species of teleost fishes, it must be presumed that the toadfish can at least hear and discriminate among its own kind, and probably can also hear and discriminate among most of the other undersea noises.

Our next question is why the toadfish makes the sounds he does. A better way to state this question would be to ask: under what circumstances are sounds produced, and in what way are the sounds related to the animal's normal behavior pattern? As to the first of these points, a toadfish in its natural environment can be made to grunt by approaching it with one's hand or a foreign object. In captivity, the toadfish will answer any sort of irritating stimulus—prodding, pushing, rapid movements, or electric shock—with a grunt. In an aquarium containing several toadfish and other species, I have heard one animal grunting at another that brushed by or approached the first too closely.

Often, the grunt induced by prodding is accompanied by a characteristic, spread-out posture of the fins and gill covers and a wide gaping of the huge mouth. If the offending probe is not quickly removed, the grunts continue and are followed by vicious snaps and bites. The grunting sounds, then, can be interpreted as a defensive mechanism. Such behavior is to be expected from a species whose normal behavior pattern is fundamentally "antisocial." Toadfish do not school, or aggregate in any fashion; they normally spend most of their time concealed in such unlikely hiding places as empty cans, discarded boots, or bottomless bottles; they are territorial in habit and discourage the approach of other fishes, including members of their own species. Pairing of male and female takes place for a short time only: just long enough for the female to deposit a mass of eggs in whatever shelter the male has chosen. Unlike most marine fishes, newly hatched toadfish do not drift away to join the other planktonic larvae: instead, they remain within the shelter for some time and eventually migrate away along the bottom. They may not move more than a mile or so from their birthplace before settling down to a life of misanthropic grunting in their various hiding places.

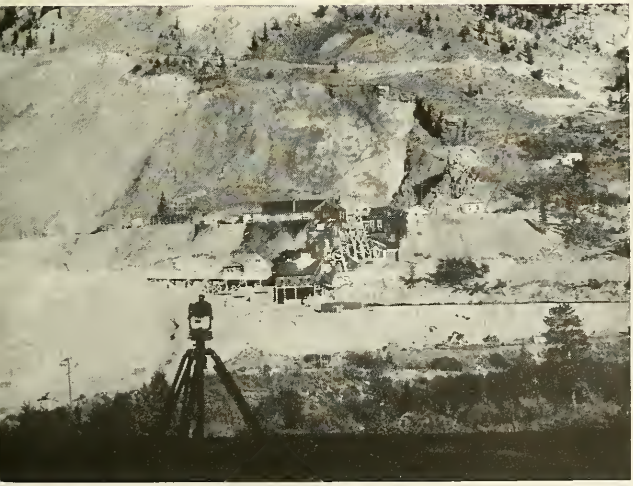
If the toadfish's grunt is a defense mechanism and a warning to intruders, what about the boop? It is often suggested that the boop sound has some relationship to spawning behavior, but this is not easy to prove. Toadfish in captivity rarely, if ever, produce the sound. Data from the field must be collected by recording the sounds in habitats where, usually, the water is turbid and the bottom muddy, so that simultaneous visual observations are difficult or impossible. It is even difficult to track down the specific individual that is being recorded. In the few cases in whi this has been accomplished, t "booper" has always proven to a large, mature male. Females, ho ever, have exactly the same air bla der mechanism as males, and the ability to grunt is demonstrably qu as good as the males'.

Dr. Tavolga, of the biology staff at New York's City College, also is a research associate in animal behavior at The American Museum.

While at a marine station in Flo ida, I had the good fortune both hear and see a single toadfish ov a period of several weeks. Herm (as he was named) lived under t station dock in about five feet water. From time to time, his bo could be heard by anyone standi out on the dock. At night, he beca more active and the blasts more f quent—sometimes as often as two three a minute. When observed w the aid of the dock light or a su marine lantern, he would sporadica move about on the bottom, foragi for food. He had a dozen differe hiding places; tin cans, sunk boards, and other trash. I watch and listened to Herman during t months of July and August, 19 and eventually I caught him on baited hook. He proved to be a m of the Gulf Coast species, and gonads were in an exhausted sta which showed he had spawned so time earlier, probably in the spri

It is clear, then, that Herma boop was not functioning in c nection with sexual behavior. T does not mean that the toadfish bo *cannot* function to aid mating duri the spawning season; but it pro with certainty that such is not exclusive purpose. Thus our answ on the function of the boop m be tentative for the present, a hedged with qualifications. Th sounds *may* serve as part of the t ritorial, "antisocial" behavior of species, by serving to delimit an a and discourage intruders.

What function, if any, these soun have in the spawning behavior cannot yet say. If some captive en ronment could be devised for to fish, wherein their sound producti is not inhibited, we should then able, with controlled conditions observation and experiment, to g a specific answer to this questi



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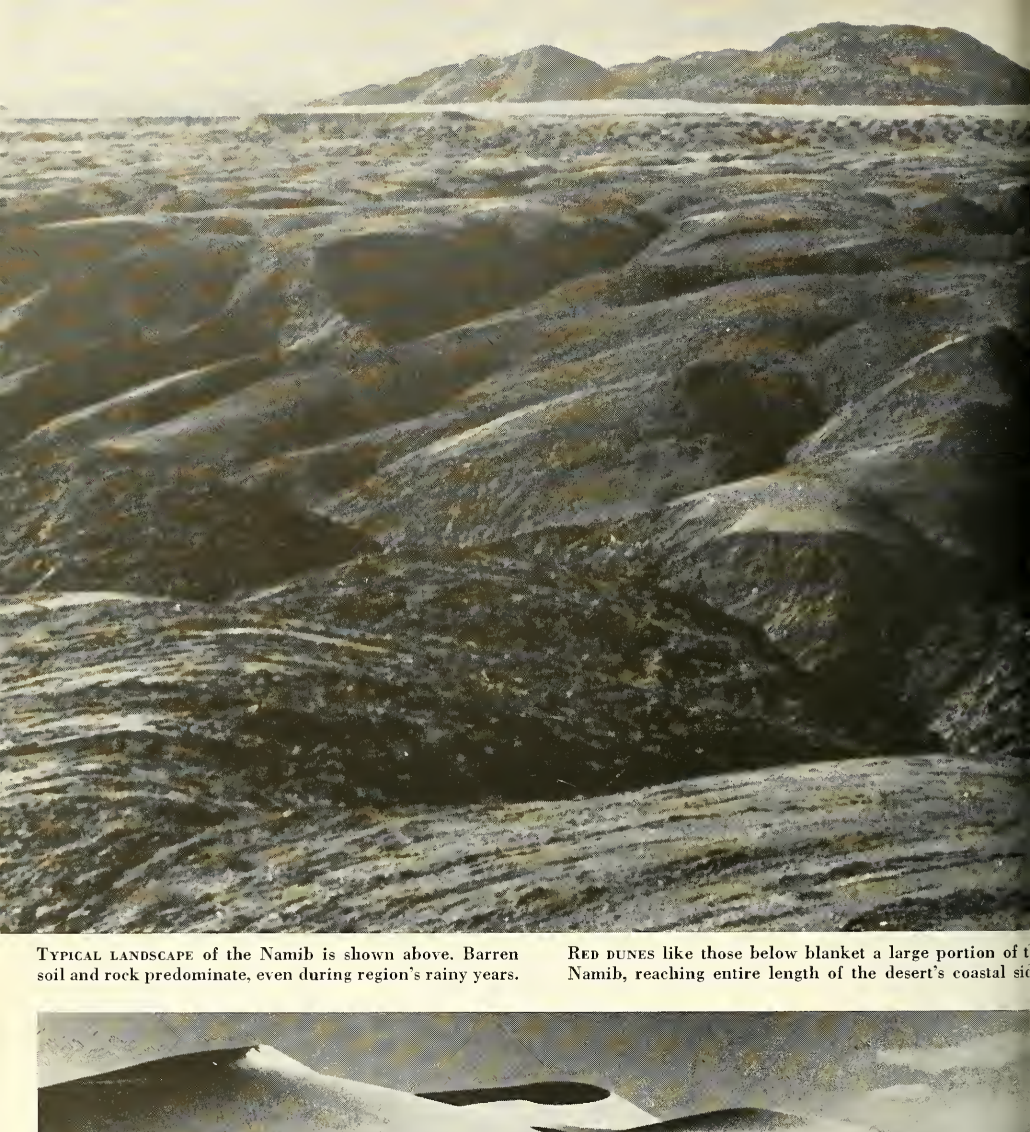
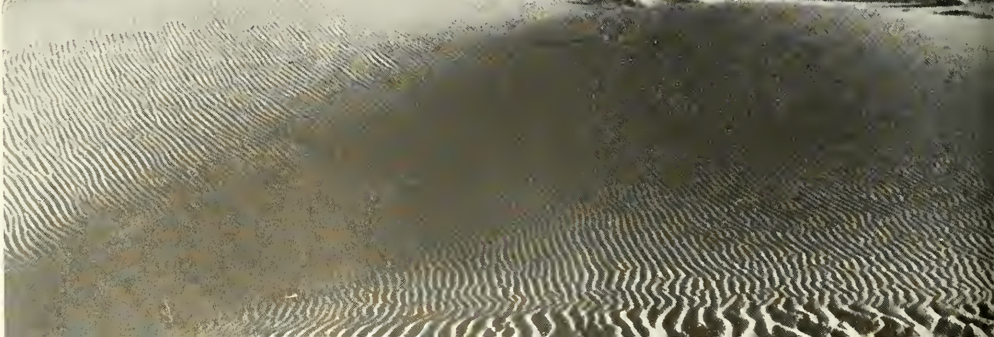


Typical landscape of the Namib is shown above. Barren soil and rock predominate, even during region's rainy years.

Red dunes like those below blanket a large portion of t Namib, reaching entire length of the desert's coastal si



A Year of the Namib

Desert stresses are relentless

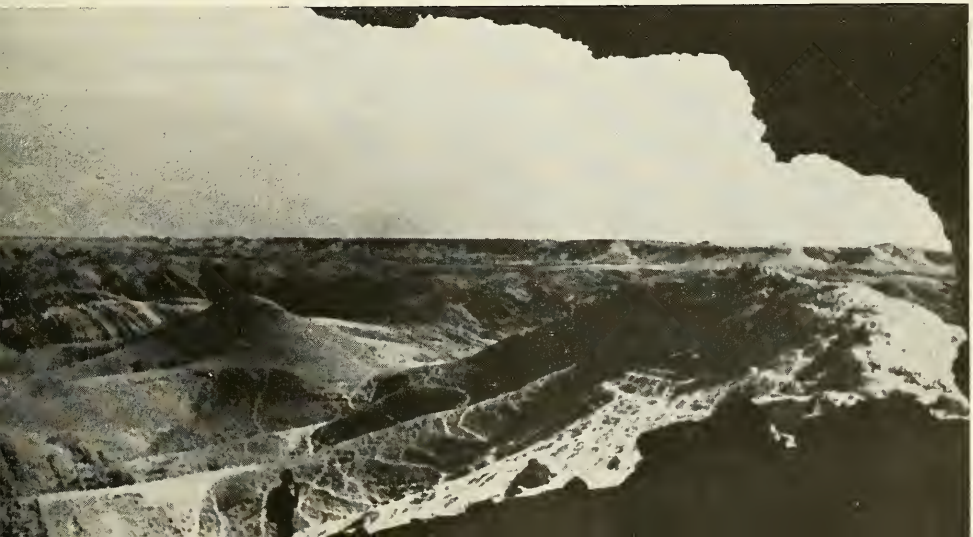
By Henno Martin

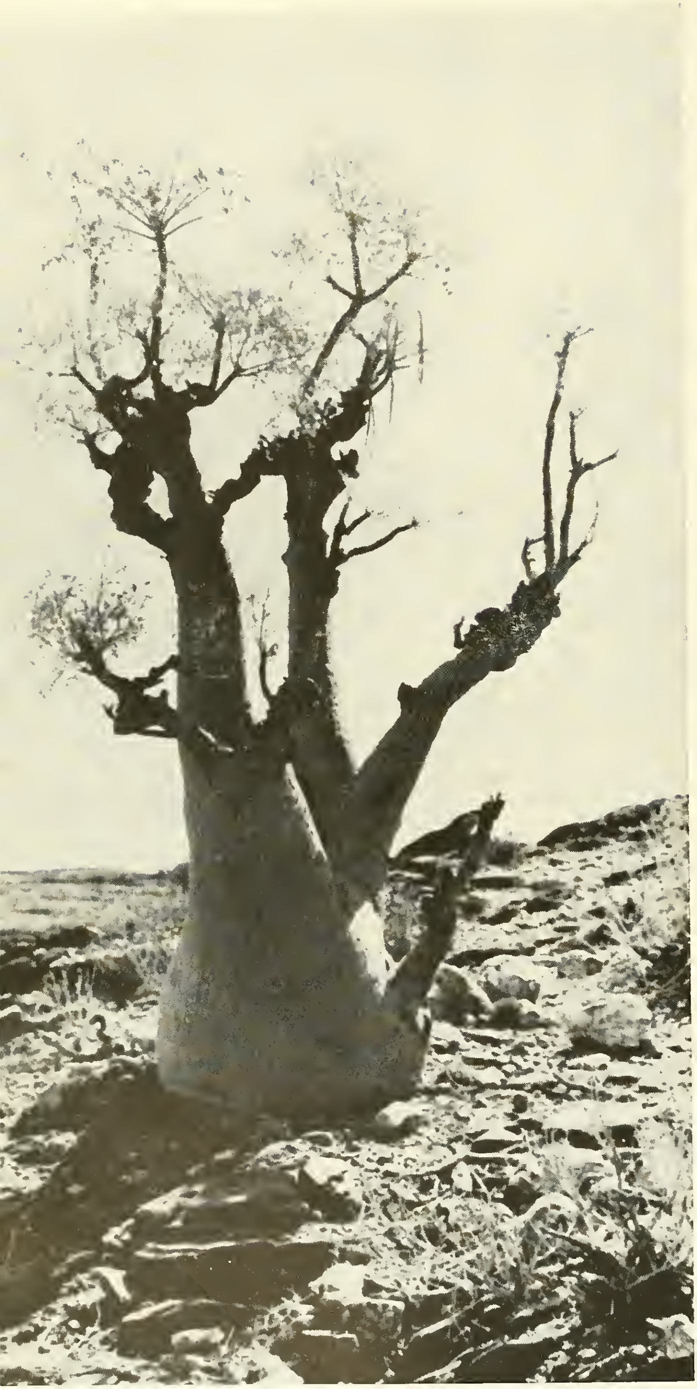
The Hottentot word for desert is "namib." The Namib Desert, itself, stretches the entire length of the thousand-mile coast line of South West Africa. Here, the great breakers of the South Atlantic pound an utterly desolate shore, cold ocean currents meeting a warm land under the burning skies of the Tropic of Capricorn. Cool mist banks may be blown inland almost nightly, but these never fall as rain. Thus, near the coast, the desert is absolute. The passing seasons bring little change and only a few specially adapted plants and animals live here.

Farther inland, the winds of summer occasionally bring enough moist air across the African continent to produce a few violent thunderstorms. Where these occur, they change the Namib from absolute desert into semidesert, producing vegetation to support large herds of game. Depending on this uncertain rainfall, the boundary between full desert and semidesert changes from year to year.

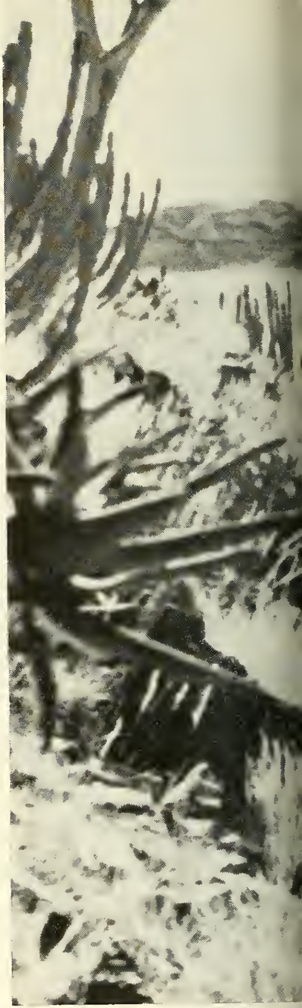
The year's so-called "rainy season" ends in April. If it has been average, parts of the Namib's vast plains will have received two to three inches of rain and will be thinly veiled by soft, nourishing, silver-fronded grass. In the less lucky areas, the sun burns down on barren, stony rubble

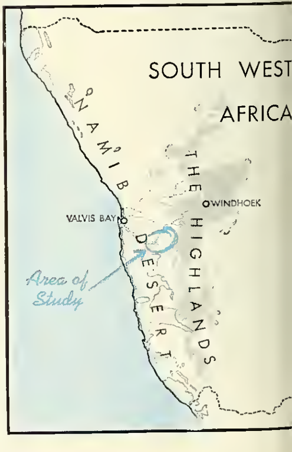
ys and canyons of Namib, *below*, form rugged terrain
ost animals, unlike klipspringers and zebras, avoid.





Squat Moringa, the tree from which oil of ben is extracted, can survive droughts by means of moisture stored in trunk.




SOUTH WEST
AFRICA
NAMIB DESERT
THE HIGHLANDS
WINDHOEK
VALVIS BAY
Area of Study

ELABRA ALOES and cactus euphorbia in foreground are l of numerous desert plants protected from animals by a poisonous sap. Across the valley, Great Escarpment may be seen in distance, separating desert from the African plateau.

oarse, glistening, granite sand. In the months that folthe earth rotates through an endless succession of t, cloudless days and cold, star-glittering nights.

IE winds of the Namib are regulated by the temperaure balance between continent and ocean. During the , the land cools more than the sea: therefore, during orenoon, the cold air flows down to the sea over the ıed desert plains. In the afternoon, when barren sand ock surface, hillsides, canyon walls, and the big red ; have been heated, the warm air rises and sucks a cool n of oceanic air into the desert. East winds and west ge with clockwork regularity, and the game herds contentedly, moving eastward in the morning and vard in the afternoon, always against the wind.

is pattern of grazing greatly reduces the danger of an ısh by leopard, lion, or human hunters. Springbok

LILY, along with other large flowers, may occasionally be found in sand round Namib's water courses after heavy rain.

Promise of rain reaches the desert, *above*, as thunder is heard in east. New grass may be half-inch high the next day.

(Antidorcas euchore), oryx *(Oryx beatrix)*, and zebra *(Hartmannae)*—all the animals that graze on the open plains follow this pattern. But not the ostriches, which rely on their fantastic eyesight to detect danger, and not the klipspringers *(Oreotragus)*, which live in the precipices of the canyon walls where the wind is always irregular.

Under the scorching sun and the dry winds, the grass soon loses its moisture and turns the golden yellow of ripe grain. But, even in this state, it provides sufficient moisture to supply the needs of the ruminating antelopes. They do not visit the fast-disappearing pools of water in the dry river beds during these months, and only seldom do they come for a little salt to one of the Namib's small salt springs. Not so the zebras. Each night, they descend

Filled with water, canyon, *below*, shows effects of rece shower. The heaviest rains occur in February and Marc

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A German geologist who spent over two years in the Namib, Dr. Martin has written a book describing his life in that region—*The Sheltering Desert*, published by Thomas Nelson.

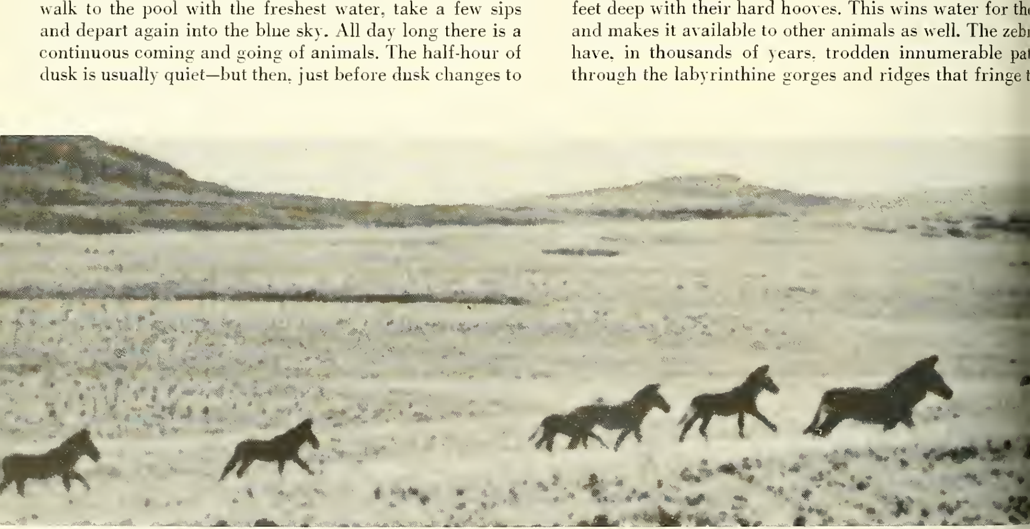
STAGNATING POOL is all that remains in river's bed a week after a storm. Even in season, rain comes only once a month.

SPRINGBOK, among fastest of all Namib animals, bound across parched grass plain. As in other grazing animals, springbo

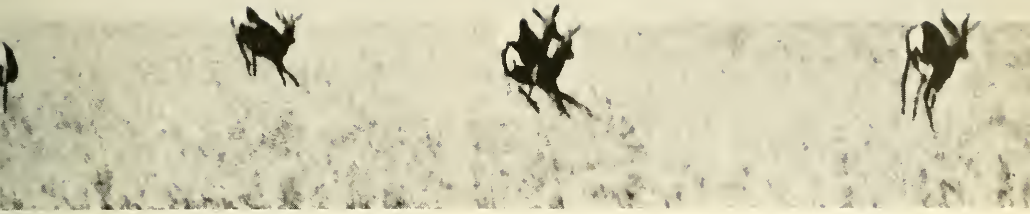
precipitous paths into the deep, wild gorges to slake their thirst. All the larger carnivores too—the leopards, hyenas, wild dogs *(Lycaon pictus)*, and jackals need a drink every other day. So, every game path that shows the mixed tracks of zebra and carnivore leads to a water hole.

About an hour after sunrise, flocks of Namaqua sand grouse alight with melodious calls, close their ranks and walk to the pool with the freshest water, take a few sips and depart again into the blue sky. All day long there is a continuous coming and going of animals. The half-hour of dusk is usually quiet—but then, just before dusk changes to darkness, by the hundreds, grouse will again fall down of the sky. Soon afterwards, the first jackal howl will p claim the beginning of the desert night.

THE zebras are the water engineers of the Namib. Th smell out the small reservoirs hidden below the sa and gravel of the dry river beds and dig holes two to thr feet deep with their hard hooves. This wins water for th and makes it available to other animals as well. The zebr have, in thousands of years, trodden innumerable pat through the labyrinthine gorges and ridges that fringe t



ZEBRAS, *above*, and oryx antelope, *below*, migrate westward into desert after heavy rain. Of the two animals, oryx are bett



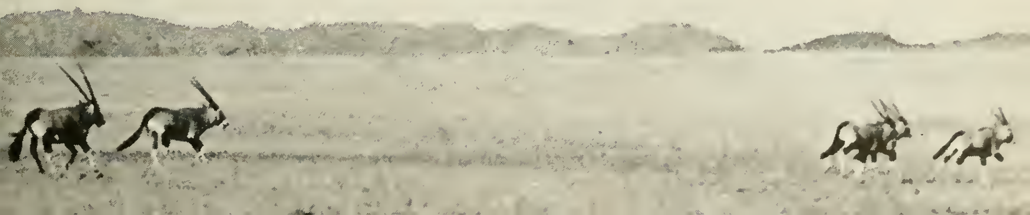
ents while feeding are eastward during the morning and westward in afternoon—always against the prevailing breeze.

canyons of the Namib. Many paths connect the dif-grazing areas of the plains; others lead to potential oles. Migrating game, not yet well acquainted with , can smell out which among the various game paths ones used by animals going to drink. The character-ud, urine (most animals relieve themselves after g), and salt smell of a water hole clings to the and can be picked up on a game path at a distance ty miles and more from the drinking place.

ptember and October, the days become longer and climbs higher and higher. Then, one day toward noon, the first cumulus clouds lift their white heads over the blue wall of the Great Escarpment which separates the Namib from the high African Plateau. In the afternoon, the wind from the sea pushes these clouds back again.

NEXT day, the cumulus towers rise earlier and higher on the eastern horizon. The first cloud shadows may travel over the Namib's parched plains and oven-hot gorges and, in the evening, the first distant lightning may play over the east like a beautiful promise. On the third or fourth day, one or another thunderstorm may penetrate

withstand drought, subsisting on residual moisture of dry grass until August, when they begin to seek out the springs.



into the Namib—shedding half an inch of rain on a few square miles of stony plain and hillside. From this storm center, the cool air flows radially away in wild gusts, spreading the refreshing smell of rain and wet earth. Thirty, fifty, eighty miles away, the animals grazing the old, tinder-dry stubble lift their heads, suck the wind with extended nostrils, and begin to walk slowly and steadily over the plains and hills and through the gorges toward the patch of newly wet earth. The ones that arrive on the next day will find the fresh young grass already half an inch high. On that day, not a single antelope will appear at a water hole. Soon hundreds, sometimes thousands, of these beautiful animals will be concentrated on the fresh grazing.

The young grass grows fast but hungry mouths work even faster. Furthermore, the moisture, which has penetrated the desert soil only to a depth of four or five inches, evaporates quickly under the hot, high sun. After a week or ten days, the great assemblage of game disappears over the horizon in search of another lucky, rain-blessed region.

In most years, November and December bring only a few similar, quite local showers. Then the noon hours, under a sun burning down from the zenith, will be almost unbearably hot. The fine sand of the river beds can blister naked feet and a man with a full water bag can die between the red, oven-like dunes. The game will seek the sparse shadow of the rare camel-thorn trees or the better protection of overhanging rocks. Fortunately, just as these days reach their worst, the rising hot air ushers in cool breezes from the sea, giving all the desert creatures a refreshing

Ostriches are among few Namib animals that do not r
on scent to detect danger when they feed or drink, dependi

Slaking their thirst, group of zebras stays by water hole. Zebras, which must drink every other day, are able to smell reservoirs of water left beneath dried river beds, diggi
holes two or three feet deep with their hooves to reach

on keen sight and refusing nourishment on slightest
n. In the driest years, ostriches do not lay eggs.

efore they face the ordeal of the following noon.
y local thunderstorm causes new migrations: an
ming with life today will be utterly deserted tomor-
is makes life difficult for the leopards. They can no
mbush their prey at regularly used game paths, be-
e antelopes do not drink at all, and even the zebras
find enough small temporary water pools to make
dependent of the more permanent supplies. The
gs are not so handicapped. Accustomed to travel
stances, they can easily follow the game. Hunting in
packs under a leader, with the same animals always
same positions as right and left flankers or back-
, the wild dogs can even bring down swift springbok
ngerous oryx. The rare cheetah, jumping from a
le-an-hour charge, can break a springbok's neck
the animal senses its danger. The scavengers of
mib, hyenas, jackals, and vultures, are present
er there is a concentration of game.

luring February and March that the fate of the next
t or nine months is decided. If the rains remain
ic, with time intervals of as much as three to four
etween showers, the migrating game will eat every-
at comes up, and there will not be enough moisture
tained growth. Then no new grass will be available
east half a year.
he grazing animals have to fall back on the year-old,
d stubble, already cropped down almost to the roots.
isture content of this old grass is so low that even
telopes must visit the few water holes and springs
ly from the end of April onward.

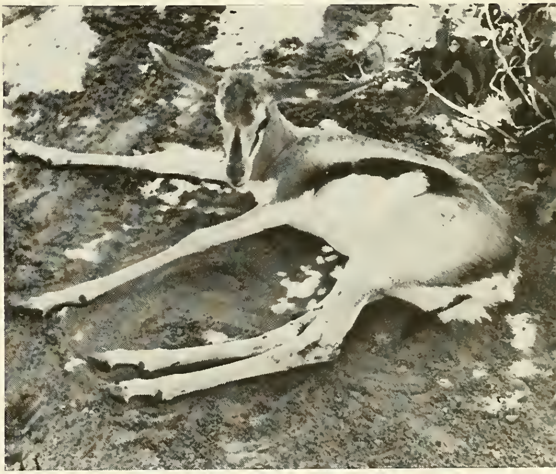
But these temporary supplies are exhausted all too soon. Now even oryx and springbok descend the precipitous zebra paths into the deep gorges in search of the all-important water. They walk many hours, often whole nights, to get there and they wait patiently for further hours at water holes yielding only a mouthful every few minutes.

Leopards and hyenas wax fat now, but the tests of endurance for the other animals are relentlessly stepped up from month to month. Not only their powers of endurance are being tried, but their power of self-command too. No one who has witnessed the struggle between thirst and prudence at a water hole tainted by a dangerous smell—a struggle that may last for an hour or more—can doubt that some animals possess this quality to a considerable degree.

In July and August, the oryx calves are born. The mothers have to hide their babies under rock ledges or leafless shrubs, concealed from the vultures, while the adults descend into the gorges for a drink. The danger from prowling carnivores is small because these hunters sleep away the hot days. But, despite precautions, few of the young will survive: the milk of their mothers dries up before there is any fresh grazing to restore their lactation.

Most of the game can still find enough old grass to subsist. But the superdry food and the lack of vitamins cause constipation, and the affected animals are soon so weakened that, after a last visit to a water hole, they will remain there, to wait in the insignificant shade of a gray tamarisk bush for the night, the hyenas, and the inevitable.

Some clever old oryx bulls know how to avoid this danger. They go westward, where there is no water but where a few patches of hardly touched old grazing still exist and, on the salty soil of some of the depressions, a species of tiny, juicy *Mesembryanthemum* grows. Their juice, it is true, is very salty but, after a moist night, the little leaves are swollen with water absorbed from the air and sometimes even glisten with dew. The oryx will fill a good part of its stomach with this wet, green food before the sun gets hot and will then proceed to the old grass.



Springbok kid lies in the shade. Predators take a smaller toll of kids than does the mothers' loss of milk during drought.

Now the Namib appears truly deserted: sun and wind seem to play over a dead landscape. Yet most of the smaller animals survive, because they avoid the heat of the day in their burrows. In the night, the geckos come out of their holes, the big tarantulas begin to prowl and, in the dunes, the beetles rise out of the loose sand. The little Namib hares look for small succulent plants, and the rock rabbits venture from their fissures, marked by white sinter-like deposits of urine, which is concentrated in a special, large, double appendix, enabling them to use the low moisture content of their food to the utmost. The rock rabbits never need any water, even in the driest years.

Such a drought cycle may last several years. Then, one day in December or February, after the east wind has been blowing stronger than is usual, a phalanx of white again appears over the eastern escarpment. The cumulus towers grow to enormous size until, one afternoon, the thunder rolls, cloudbursts drench the plains, and rivers in spate roar through the canyons. More rain during the next days and weeks penetrates the soil down to bedrock. Green grass begins to wave from horizon to horizon; flowers lift their gay heads everywhere. The game returns, and soon new springbok kids and zebra foals gambol around their mothers. The herds of game move west, as far into the desert as possible, because the shortest grass is the most nourishing. When at last they move east again, the plains of the Namib are golden with mature grass extending as far into the distance as the eye can see.

Such a rainy season assures a plentiful food supply for the desert grazers for as long as the next two years. But this abundant rainfall comes only about once in every eight years. It will therefore not be long until the bitter struggle for survival in the Namib desert commences once again.

Tarantula, like insects and lizards, survives in the hottest season with relative ease, leaving its burrow only at night.

Lonely guard over dead zebra is kept by watchful marab
which shares Namib's carrion with vultures. During the

game is mobile and is readily killed only by swift s or packs of wild dogs. In the hot season, when game routes lead to few permanent water holes, exhausted zebras or antelopes fall easy prey to leopards and waiting hyenas.

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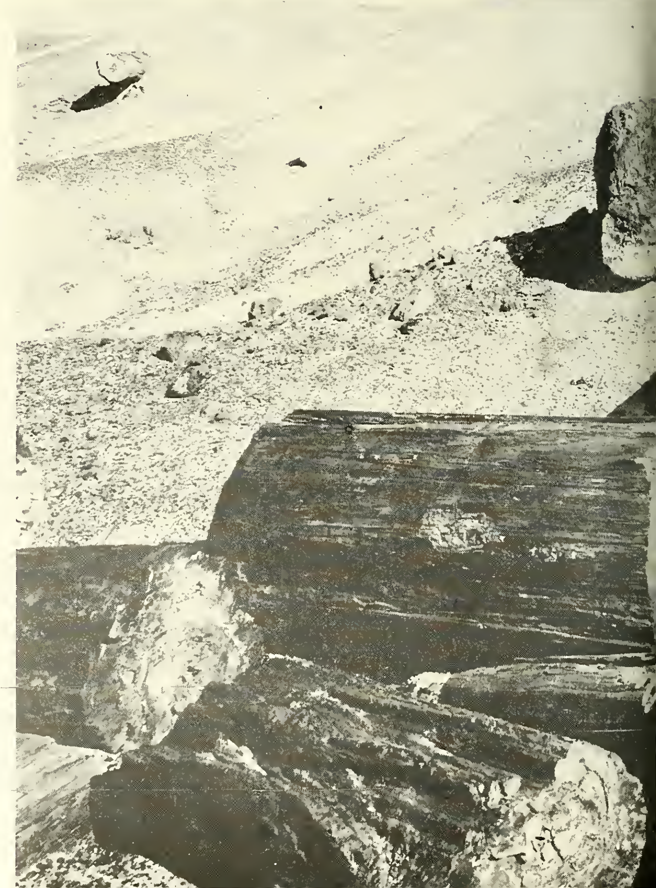
NATURE IN ROCK & MINERAL

By Paul Mason Tild

Scattered here and there over the North American continent—and about the other continents as well—are forests from which no logs are ever taken to the mill. No birds sing among these branches, or drum on bark in quest of insect prey. The small anim that once roamed the litter of for floors in search of nut and cone are l vanished; bole, bark, log and branch as silent as stone. Indeed, they *are* sto for these are the petrified forests.



Colorful fossil logs that weather out of the Chinle sediments, *below*, in north-eastern Arizona are believed to be re of stream-carried forest debris. Many

gh a fortuitous combination of
al circumstances, the wood of
-life has been preserved in min-
ı, usually by one of the varieties
z—such as jasper, chalcedony,
opal, or some combinations of
though, now and then, the orig-
od has been replaced by such
as pyrites, gypsum, native cop-
ite, or even radioactives like
, autunite, or torbernite.

f the better-publicized localities
ied wood in the United States
ada are in the arid West, a cir-
e that has helped foster the no-
petrified wood is something of
n monopoly. Such a cowboy—
petrified forest association is a
one: it is not, as a matter of
lly accurate.

ue that the West affords some
kable and colorful occurrences.
enowned "rainbow forest," near
. Arizona, the choicest part of
as been preserved as national

nal trees were distant relatives
nodern pines as the araucarias.

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Through correspondence, Mrs. Sonia Busch became more than a name to Chung San Kim . . . more than a sponsor. He called her, "Sister whom I only can see in dream."

Poignantly he wrote:

"Autumn has stolen away, and now it is early winter here in Korea. The skeletonized trees without reddened leaves are standing lonely . . . Praying for the happiness of my sister."

At the end of every letter he drew a picture to illustrate his thoughts.

With drawings and words touched by poetry, Mrs. Busch in Millbrook, N. Y. knew that in Chung San Kim's eyes, she is a *beautiful American.*

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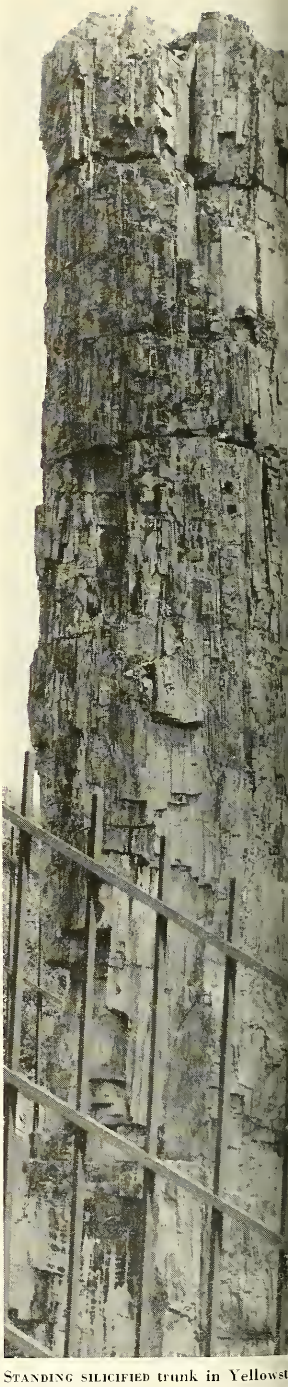

STANDING SILICIFIED trunk in Yellowst
Park attests to vulcanism of times

IASON TILDEN, formerly an of NATURE MAGAZINE and a id mineral collector himself, ntinues his regular column in es of the combined magazines.

in the Petrified Forest National it. Here, certainly, is a great of brightly colored logs, threat- earlier years with destruction by souvenir and mineral col- it by the activities of an enter- if somewhat unimaginative, firm bent on converting the eritage into commercial grits. est possesses another petrified is one composed of primitive lled cycads, the supposed an- our modern flowering plants— s also been preserved in the ls of South Dakota for the pub- Cycad Forest National Monu- me of the specimens in the rest actually exhibit the devel- of fruit and the young crowns unfolding, as they did in life undred millions of years ago. are also the great fossil forest i of the Yellowstone, the spec- ircle Cliffs Petrified Forest in the wild back country of southeastern Utah, and many other such notable localities in Oregon, California, Nevada, Washington and other western and southwestern states.

SCOTIA, tree's soft inner tissue iced by sandstone, forming cast.

Fanciers of the "biggest" and the "longest" among petrified trees may point to an area near the village of Leadville, Nevada, north of the Black Rock Desert, where stands a fossil stump some fifteen feet high and forty-six feet in diameter. In the same state, near the town of Coalville, a trunk measures nearly 300 feet in length. Both of these giants of the world of fossil wood belong to the genus *Metasequoia*, closely related to the so-called "living fossil" species of tree still extant in China.

THE eastern half of the North American continent however, is by no means devoid of such relics of ancient forest life. From the Maritime Provinces of Canada, south along the Atlantic seaboard and along the coast of the Gulf States, there are many localities where petrified wood may be found in some abundance—less colorful, perhaps, than that of the West, and less obvious to inquisitive eyes because of the nature of soil and vegetation.

If the East cannot boast the most colorful, it can at least lay claim to what is probably the most ancient of the fossil forests yet discovered in North America. At Gilboa, not many miles southwest of Albany, New York, construction work for a reservoir revealed the fossil stumps of a forest that flourished during middle-Devonian time, some three hundred million years ago. Relics of forest life that antedate the old forest of Gilboa are not common anywhere in the world.

COLLECTORS sometimes wonder whether any of the animal life that must have been intimately associated with the ancient trees is ever found with, or in, them. The answer is "yes, but not often." Occasional pieces of petrified wood exhibit the scrollwork of bark beetles and the nibblings of other wood-eaters, but few of the animals themselves seem to have obligingly stayed with the petrifact-to-be.

At Joggins, Nova Scotia, not far from the narrow neck of land that connects that province with New Brunswick, there is a series of petrified forests, piled one atop the other like the layers of a cake. In life, these woodlands occupied a great marshy area that was undergoing a geological sinking movement and seems to have been a catch-basin for accumulating sediments that later became solid rock. Here, during late Paleozoic time, there flourished rich stands of the primitive plants known as scale-trees, each successive forest growing up over its dead predecessor, to eventually leave its remains in great profusion in the forms of sandstone "casts."

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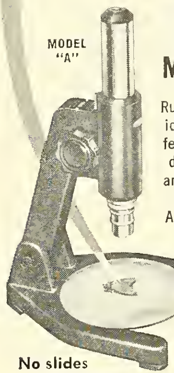

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Within the sandstone-filled, hollowe
out stumps of some of these early tre
have been found the remains of snak
like amphibians of the time, as petrifi
as the stumps that formed their shelte
ing-places. And with the bones we
found, also, the shells of land snails th
had been eaten by the animals.

From one of the Oregon petrifi
wood localities have come fragments
fossil wood that exhibit small hol
made by some species of termite; wh
another locality in the same state affor
petrified logs that exhibit not only t
ravages of teredo worms but, in so
cases, the fossilized worms themselv

In the ordinary course of events,
forest tree—ancient or modern—li
out its life, dies, and slowly returns
the soil by way of organic decay and t
attack of animal and plant life. The
currence of petrified wood in an a
seems to indicate that something out
the ordinary, geologically speaki
must have happened to preserve the or
inal timber.

The trees of the multi-layered fos
forests of Nova Scotia, for example,
parently flourished in marshlands t
were periodically flooded with water a
its accompanying rush of sedime
while a local downward movement of
earth's crust assisted in the progress
burial of forest debris, logs, and stum
In this case, the downward movem
must have been nearly equal in eff
to the upward accumulation of pl
debris and sediment deposit, keep
the whole process on an even keel, so
speak, and eventually resulting in a s
cession of buried forest "horizons."

In contrast to this slow process
burial was the sudden and violent in
ment of standing forests like those t
once flourished on the Yellowstone
teau of Wyoming. In Yellowstone
tional Park, on the flanks of Ameth
Mountain, a vertical section of m
than two thousand feet of fossil for
is exposed. There, to borrow a phr
from an early observer, "rows of
right trunks stand out on the ledges
the columns of a ruined temple."
least eighteen separate forests are
vealed, piled one on the other, e
overwhelmed in turn by widely spa
eruptions of volcanic ash.

Still a third and somewhat more s
ulative method of tree burial is invo
to account for the preservation of s
tered logs like those of the colo
"rainbow forest" of northern Ariz
Most of the trunks that weather f
the brightly colored sedimentary
of the Petrified Forest National M
ment seem to have been stripped of t
bark before they arrived in the a
This, of course, suggests that the
may have been barked as they were
ried along with the waters of moun

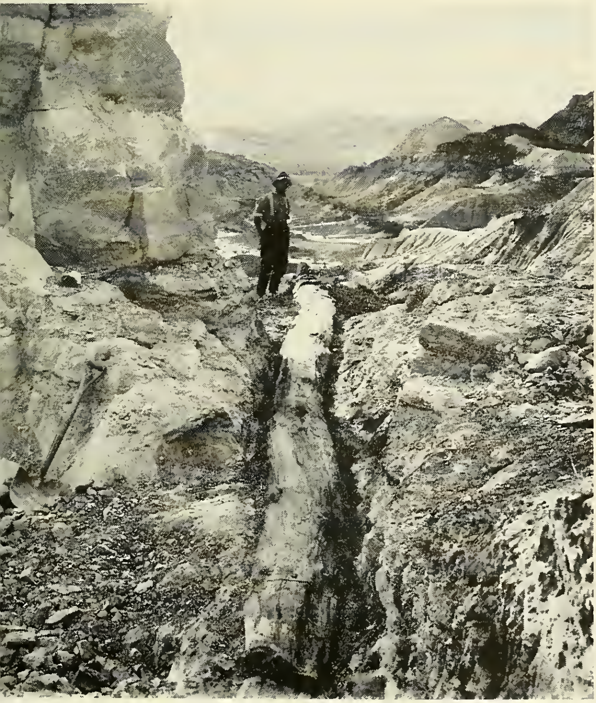
in spate. It may be imagined end of this wild ride to geolog- came as the floodwaters sub- d the logs were stranded here , to be covered and later buried eding rushes of silt and sand.

sliver of wood—or a forest of mps and logs—has been safely n sediments, away from free nd the attack of living scav- etrifaction may ensue by way subtle process, one whose exact s are still a matter for study anation.

ocess by which the substance is replaced by mineral matter to mineralogists by the rather le title of metasomatosis—liter- xchange of bodies. Percolating ater, carrying with it dissolved other minerals, exchanges its olecule by molecule—or even atom by atom—with the sub- the wood. Upon completion of ge transaction, the wood is said trified, whether it has finally erted to one of the minerals of z family or another mineral.

ubstance of the wood has been by a quartz mineral—precious instance—it is said to be silicified, and may possibly furnish gem stones like those of the famous Virgin Valley opal fields in Nevada. If the replacing agent is some other mineral, the wood may constitute a valuable commercial ore, as in the case of the carnotite deposits of the Colorado Plateau. Along the San Miguel River, in southwestern Colorado, two petrified logs were recovered—one of them measuring nearly a hundred feet long and four feet in diameter—which, after milling, yielded more than $230,000, in uranium, radium, and vanadium ore!

But broadly speaking, the sentimental and educational value of the petrified forests far outweighs their relatively small commercial worth. In Navaho Indian legend, the colorful logs of the "rainbow forest" of northern Arizona were the bones of a monster who was destroyed by the sun; and to the Paiutes they were the discarded weapons of the great Wolf God. To many modern collectors, who believe in neither monsters nor gods, a worm-eaten slab of stone bark or a polished cross section of the tree life of the remote past is well worth a place with the finest crystals of a collection. These are bits and pieces that seem to make the geological past a little less impersonal.



UNK, some fifty feet long, was gth of driftwood hurried along by an Upper Cretaceous stream in what is today the Red Deer Valley of Alberta.

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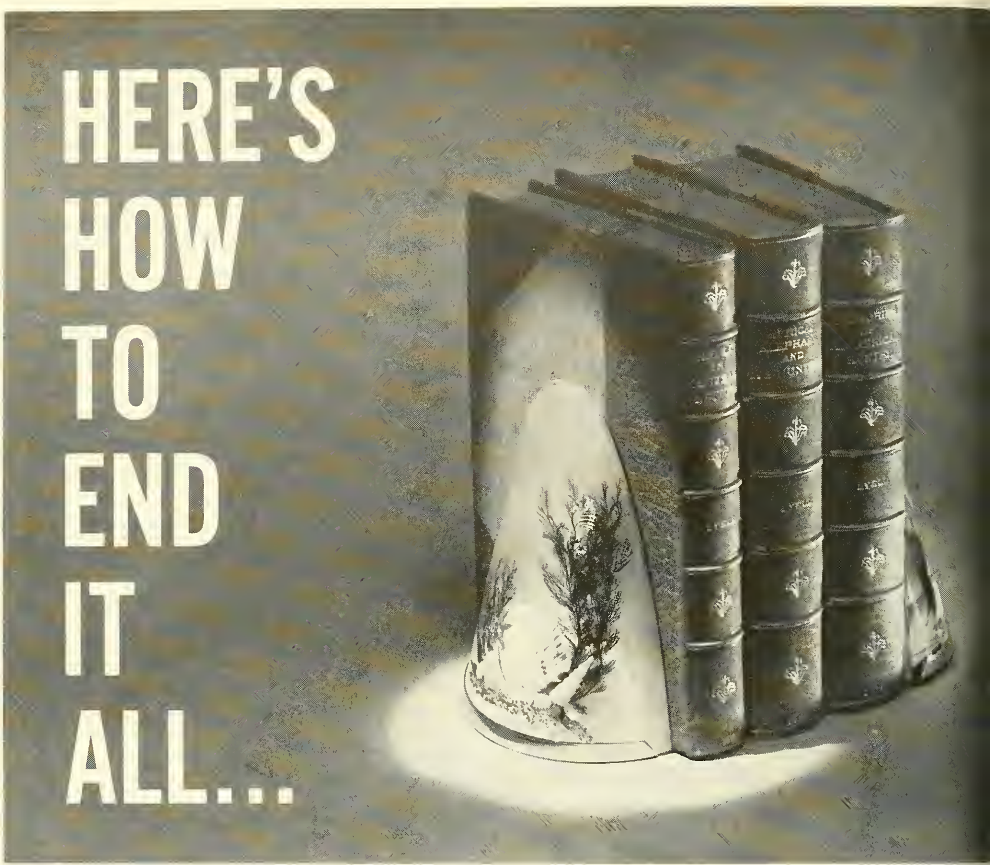

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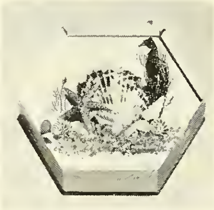

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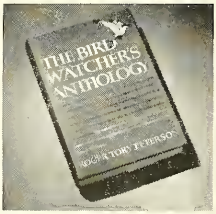

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EWS *(Continued from page 6)*

ical student. Harry J. Fuller, dor of Botany," reinforces the and suggestions of Cox and n "Botany for Living." C. J. evaluates the role of botany in our citizens of the future. He that botanists should be ready information and assistance to ens as more of them enjoy life urbs, take more frequent and ps into state and national parks wild areas, and are allowed time in their retirement years lt of an increase in longevity. ulross Peattie, in a paper "On arization of Botany," writes of resting experiences as a popu- botanical information and of ssional barbs he has received lt of his work.

JACK McCORMICK
THE AMERICAN MUSEUM

FIELD GUIDE TO AMERICAN
EAST, CENTRAL AND NORTH,
Hill Collins, Jr. *Harper, $6.95*
edition $7.95); 200 figs., 48
es, 778 maps, 683 pp. Illus. by
rancis Peterson, Nina L. Wil-
John Cameron Yrizarry.

ook is ambitiously designed to e field identification of "all birds, mammals, reptiles, am- food and game fishes, sea- d the principal marine inverte- ccurring annually in North east of the Rockies and north th parallel"—a total of 1439 The text includes descriptions nents on ecology, behavior, and ion; these are most detailed and most abbreviated for the ites. Range maps are provided of the vertebrates.

ious limitation of the *Complete ide* are the illustrations of the birds and mammals. These fall far below the standards set by the excellent guides currently available for these groups, and will be of limited value in field identification. The decision to include illustrations of bird eggs was unfortunate, for they add nothing. By way of contrast, Yrizarry's plates of reptiles and amphibians are well done, handsome to look at, and useful in the field.

In view of the pretentious scope of this volume, readers may be amazed at the amount of space devoted to irrelevant material and features of questionable value in a field guide. The geologic age is given for many groups; the genus of the box turtle, for example, "goes back to the Miocene." Poetry is quoted freely, as with the six lines from T.C.P. Wilson's "Magpies in Picardy" about magpies in Picardy. There is an original bit of prose about the raccoon: "Coonskin hats, coonskins coats, and coons in general are part of pioneer America, recent America, and outdoor America. And all the while old Ringtail sits in his hollow tree, or washes his finny dinner, and somehow pulls through into the Space Age." And we are informed that if one watches the courtship of the Brewer's blackbird one may see "the ruff-out, male precoitional display, female generalized display, female precoitional display, male elevated tail display, head-up display, walking together, mutual display, the dart, and the chase."

The desire to relieve the burden of the field student of nature by creating one guide to do the job of four or five is a commendable one. Perhaps it is even possible. To accomplish this feat, however, without sacrificing quality and standards, will require a fusion of talents for editing and illustrating that has not yet been achieved.

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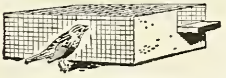

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Ominous dorsal fin cutting the water, killer whale surfaces, perhaps to look for food, at edge of the Antarctic ice sh

The Wolf of the Sea

A visitor to Antarctica gets a unique close-up of a killer wha

By Joseph Curtis Moore

A member of the American Society of Mammalogists, Dr. Moore chairs its Committee on Marine Mammals.

Powerful, swift, and rapacious, the killer whale may be losing something of its fascination (and fearfulness) for the man who, from the solid deck of a factory ship, may now view the beast with less concern than did earlier generations of whalers. Even when man at sea on a small modern vessel encounters killer whales, he may feel no emotion greater than the thrill of actually witnessing a band of these bold, black-and-white "wolves of the sea." Their contrasting colors and the towering dorsal fins of the old males provide a spectacle to remember, as a school of the twenty-foot-long killers breach the surface to breathe at intervals. Then they pass beyond ken, in obedience to the unknown drives that steer their apparently purposeful course.

For one more intimately involved with the forces of the sea, such as an Eskimo in his frail kayak or a fisherman in an open boat, close exposure to these voracious predators can test all of a man's courage.

In the Antarctic, one of the more precarious conditions under which a man may encounter killer whales is when walking on the sea ice near open water. If normal prey—seals or penguins—is not easily available, it is thought that killer whales, seeing men on the shore, may batter and break the ice sheet from beneath and spill the unwary into the water to their death. Killers have also been reported to attack the greater whalebone whales, and may even kill an adult one occasionally. The glistening, black and white head of the Antarctic killer, elevated so that the small, black eye may view what is on top of the ice, as Morton Beebe has captured it here on film, may well indicate that this whale was considering the photographer as a potential victim.

Shortly before the picture was taken, Mr. Beebe notes, the shore line came alive—as penguins and seals thrashed out of the water in wild alarm and scurried across the ice in search of safety. Realizing that killer whales were in the vicinity, Mr. Beebe and his companions deliberately tried to attract them by jumping up and down on the ice, which they judged to be a reasonably safe eight feet
thickness. The whales did rise
pound the ice underneath them,
Beebe says, and when cracks de
oped, the amateur experimenters f

Bits of new information ab
killer whales become availa
occasionally. In 1945, a school
twenty were stranded on the Pac
coast of Vancouver Island. A lo
scientist measured and compared
individuals of this one pack. It
adult females may substantially
ceed fifteen feet in length. The smal
of thirteen beached females was
immature fifteen feet, four inches;
largest—nineteen feet, five inches
potentially important source of m
new information is a small whale f
ery in Japan that takes about s
killer whales a year. A report of
years' activity shows, for insta
that killer whales are born about
feet long, and that adult males
grow to reach an extreme length
as much as thirty-one feet.

Murderous head is silhouetted aga
icy wastes, *right*, as killer shoots
of water and balefully eyes the cam

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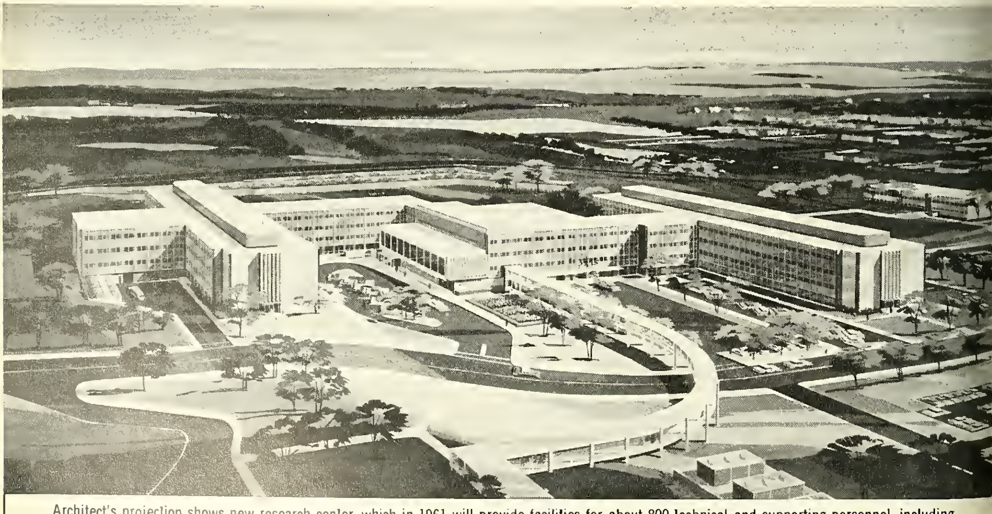

Architect's projection shows new research center, which in 1961 will provide facilities for about 800 technical and supporting personnel, including chemists and engineers from the inorganic chemicals, organic chemicals, research and engineering, plastics and petroleum divisions of Monsanto.

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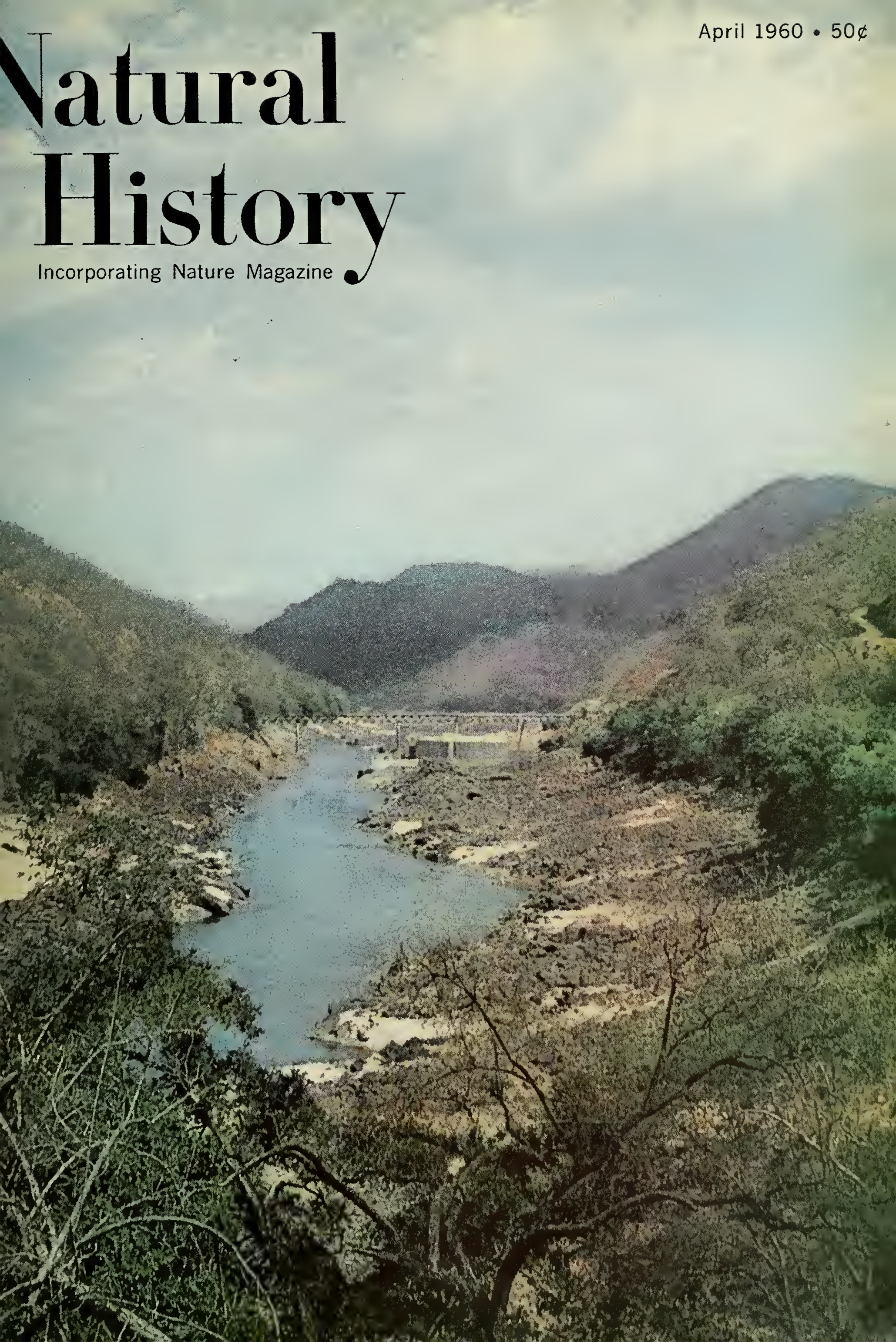

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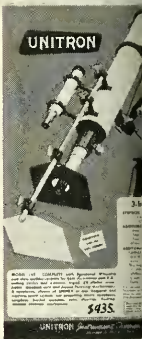
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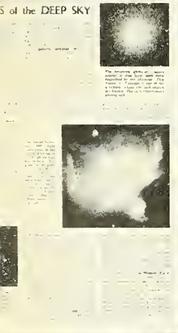
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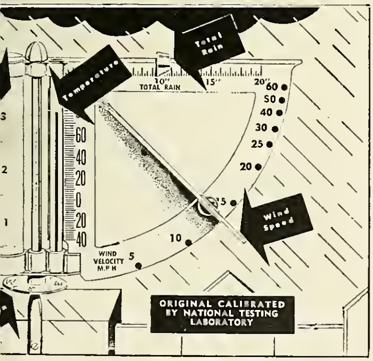

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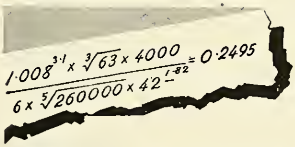

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COVER: In its course between Northern and Southern Rhodesia, the Zam
River is broken by the great Kariba Dam, whose beginnings in 1956 are s
here. The structure will be dedicated by the Queen Mother next month, an
1962 will create an artificial lake with four times the capacity of the Color
Lake Mead, bringing cheap power to Rhodesia. This has meant resettlemen
the 50,000 Valley Tonga people, whose move has transformed part of Rho
into a vast laboratory, affording a unique chance to study the effects of a
environment on a given culture. For this study in human geography, see pa

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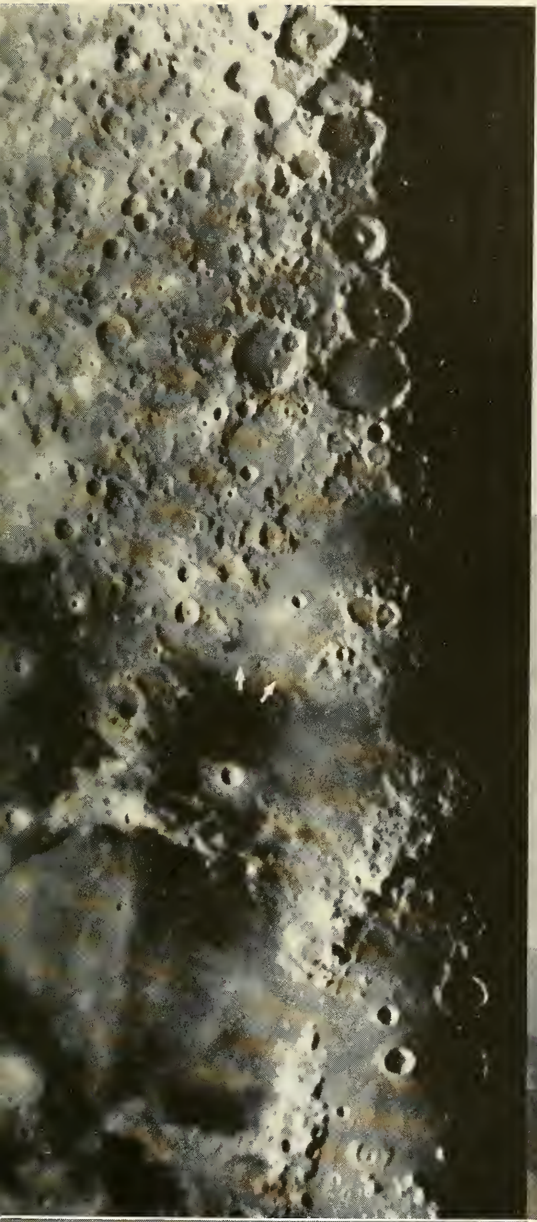

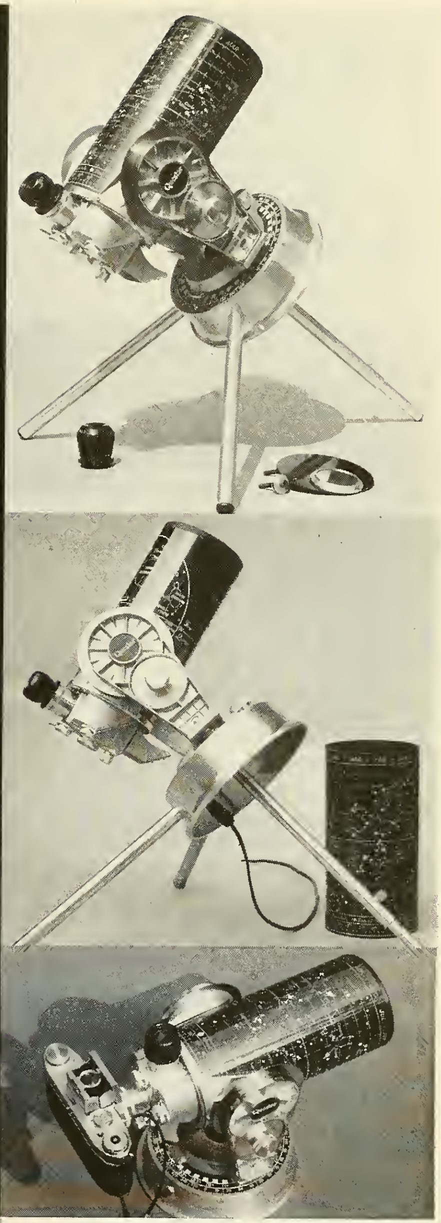

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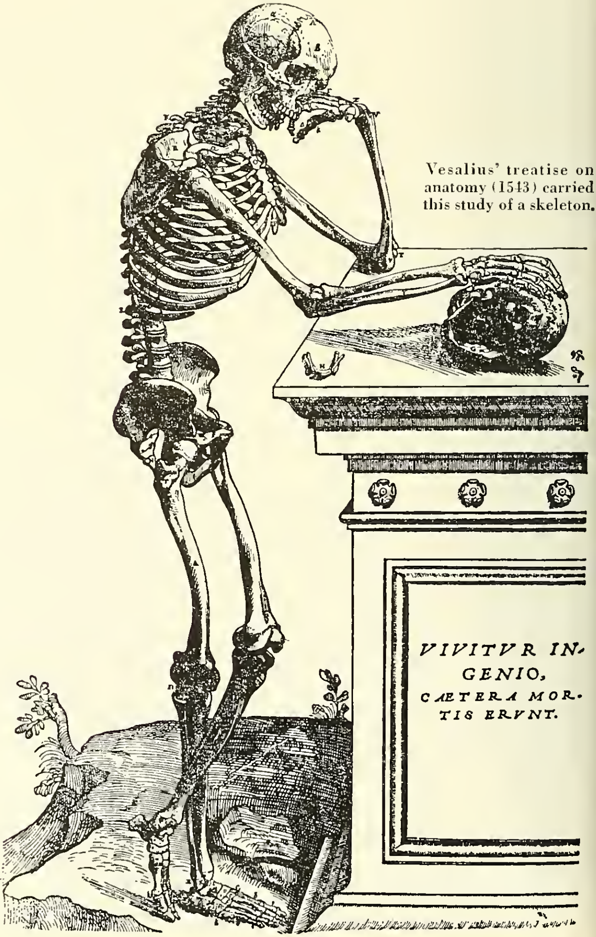
Reviews

The Function of the History of Scienc

By CHRISTOPHER GEROU

In a recent and much-discussed lecture, the English physicist—novelist C. P. Snow expressed a concern that has been growing in other quarters as well. His argument, in brief, ran that there is an increasingly wide split between what he calls "the two cultures"; on the one hand, the classic academic culture based on the humanities and the arts; on the other, the scientific culture based on exact observation and experiment and on the rigorous logic of mathematics.

As a result of increasing specialization and, particularly in the years si
World War II, as a result of the hotho
forcing of scientific talent in colleges
universities—usually with a heavy wa
ing of government subsidy—there is
ever-widening cleavage among schol
and thinking people in general. T
may be "cultured" in one of two sen
but seldom or never in both. As a res
Snow feels, there is a dangerous gro
of misunderstanding between men w
typically, regard either an appreciat
of Renaissance painting or an appre


VIVITVR INGENIO, CAETERA MORTIS ERVNT.

Vesalius' treatise on anatomy (1543) carried this study of a skeleton.

GEROULD, who reviews regularly ATURAL HISTORY, reports here on ges between "the two cultures."

he second law of thermodynamics sort of thing that every cultured shares. With misunderstanding a senseless competition between o cultures"—each trying to estab- elf at the expense of the other.

mber of representatives of both attled "cultures" have quarreled ow in detail, but few have tried the general tendency to which nts. The fact remains that the liberal arts graduate has long iven up trying to understand the t manifestations of applied sci- uch as his own radio set—let alone ting to be even generally aware t is going on, on the advancing s of any of the sciences. He has, t, reconciled himself to one kind racy.

he other side, the gap is equally . Even the most sophisticated ts are apt to grapple with the language with all the innocence ère's *bourgeois gentilhomme*, who realize that he had been speaking ll his life. On the lower levels tific endeavor, the industrial sci- or engineer has often given up the attempt to explain what he to anyone outside his own lan- group and relies instead on the on of a "technical writer" who both English and "Scientese."

NATELY, however, the wall be- en the two cultures is being d with increasing effectiveness by that sits directly *on* the wall— dents and scholars who are con- with the history of science.

the twentieth century, there was impetus for a scholarly study of ory of any science. The scientist , in the course of his apprentice- ecame sufficiently aware of the origins of most of his basic data hniques. Nor was he much inter- n looking back—the view ahead o much challenge. As a result, few noteworthy studies were in the last half of the nineteenth , they were not much regarded. e last few decades, however, the ation of scientific work—and that find one's past that exists in e—has increased the concern of "scientific culture" with the two emes of its history: the main- of development of individual dis- . and the relation of scientific ast and present, to the rest of history—to politics, religion, ics, and art.

neer and one of the greatest of entific historians was the late George Sarton, first professor of the history of science at Harvard and the founder of two scholarly journals in the field. Sarton brought to his studies a tremendous classical background as well as the necessary scientific one, plus a conviction that the history of science was part and parcel of history as a whole, not some sort of separate and parallel development. As a result, his monumental *History of Science* is unfamiliar but very rewarding ground to the scientist who digs into it for the first time. It bristles with references and all the painstaking textual detail of careful classical scholarship. At the same time, it traces connections not only between the scientist and his predecessor but also between the scientist and non-scientific contemporaries who often influenced him as much or more.

A pocket-sized sample of Sarton, and a good one, is his *Ancient Science and Modern Civilization* (Harper Torchbooks, 95¢). In this series of three lectures delivered in 1954, he covers the flowering and decline of science in the Hellenistic age from 300 B.C. to about A.D. 400. In essays on "Euclid and His Time," "Ptolemy and His Time," and "The End of Greek Science and Culture," he epitomizes a period in the history of science that continues to be one of its greatest periods.

ONE-VOLUME histories of science suffer from almost as great an impediment as the one-volume encyclopedia. Among them, Charles Singer's *A Short History of Scientific Ideas to 1900* (Oxford, $8.00) is the latest and quite probably the best. Dr. Singer—chief editor of the monumental, five-volume *History of Technology*, recently completed and not likely to be superseded—writes with distinction as well as with the clarity so necessary in a work of this length. The *Short History* could well serve as an introduction to science-as-a-whole to any member of Snow's non-scientific culture. From it he could, if he wished, possess himself of a wider scientific background than is owned by many scientists. The illustrations are many and good; but the index, unfortunately, lists only names.

Allowed more space, Singer spreads himself to even better advantage in the essays collected in the volume *From Magic to Science* (Dover, $2.00). One of the essays is a full-scale treatment of science under the Roman Empire. The Romans, he points out, were at their best in nature study and at their worst in pure mathematics, and perhaps too concerned with rhetoric to be notable in any field of science. In his second study, the author traces the submergence—and survival abroad—of ancient scientific learning during Europe's Dark Ages and shows how classic works were recovered, again to become vital forces in the scien-

(Continued on page 76)

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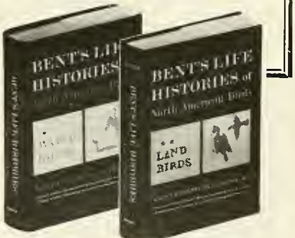

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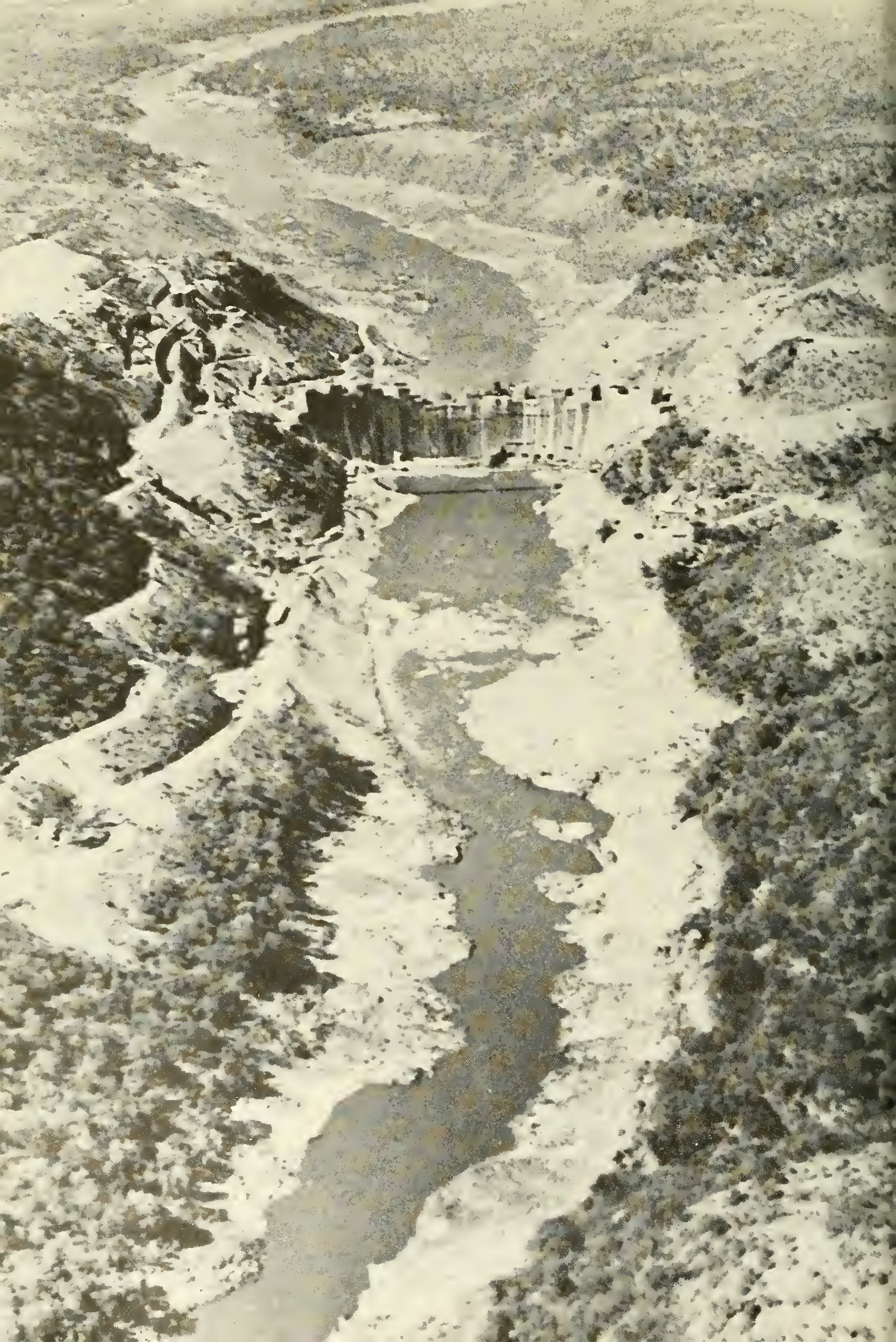


I:

Environment and a Culture

ey Tonga resettlement is a case study in human geography

By Thayer Scudder

ɪɢ ɪɴ Nᴏʀᴛʜᴡᴇsᴛᴇʀɴ Rʜᴏᴅᴇsɪᴀ, the great Zambezi ʼer literally cuts its way through the Central African en route to the Indian Ocean, some 1,800 miles long its middle reaches—which form the boundary Northern and Southern Rhodesia—the vast Kariba ıs been recently completed. By 1962. an artificial er a hundred and fifty miles long and in places iles wide, will be created—with four times the stor- ıcity of the Colorado's Lake Mead, now the world's artificial reservoir. Cheap power, flowing from s generators, will be sent directly to the Northern an "Copper Belt" and to the larger Southern an urban centers, where it will play a critical role eveloping economy of the political entity known as tral African Federation.

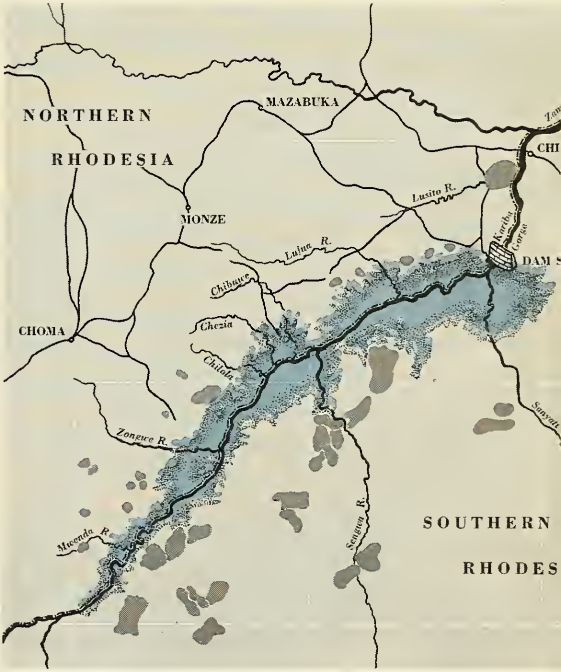
; over 2.000 feet below the Central African Plateau me of practically the entire European and Asian on of Rhodesia, and of most Africans). the area ɔoded is remote indeed. Before 1950, much of it wn only to a small number of Europeans and, even izable areas of this upper portion of the Middle i Valley are visited annually by only a few whites— government officials.

egion is inhabited, however, by over 50,000 Afri- illed the Valley Tonga—whose ancestors first settled ıe banks of the Zambezi and its major tributaries centuries ago, when Bushman bands probably still hroughout the area. Perhaps the Valley Tonga first ɔut this region as a refuge area from the more war- ɔes that periodically have swept through southern tealing cattle and plundering villages. Today, how- ıen even the most remote areas in Africa are being ıp. this once isolated area has ceased to be a refuge. its inhabitants have been resettled inland from ıg waters of Lake Kariba.

ʜ such a large area soon to be inundated and lost science completely, a study program of the pro- ıke basin and adjacent areas was organized, and l with generous support from the Federation Gov- of Rhodesia and Nyasaland. While all research lvage-oriented"—insomuch as a permanent record eology, archeology, geography, anthropology, and of the area was desirable—much of it will supply important base-line material for subsequent research. Given knowledge of the area before its inundation, the effect that such a large body of water will have on the fish of the Zambezi, or on vegetation and climate, can be subsequently studied. Of perhaps even greater interest, the effect of resettlement on the subsistence economy and social system of the Valley Tonga, themselves, can be followed. How long, for example, will it take them to re-adapt to new surroundings: what factors will be significant in determining the changes that are bound to occur within their society? The Kariba Lake Basin, in this context, becomes a vast laboratory for the study of cultural and environmental change.

As one of several scientists appointed within this program, I came to Rhodesia in September, 1956, as a Research

Dᴀᴍ is seen from air, *left.* Dam will give Rhodesia cial lake with four times the volume of Lake Mead.



Rᴇsᴇᴛᴛʟᴇᴍᴇɴᴛ ᴀʀᴇᴀs for Valley Tonga after new lake has flooded Zambezi Valley are shown in gray on the map, *above.*

A Harvard geographer, MR. SCUDDER studied the Valley Tonga for the Rhodes-Livingstone Institute in 1956-57. He plans soon to investigate the effects of the resettlement.

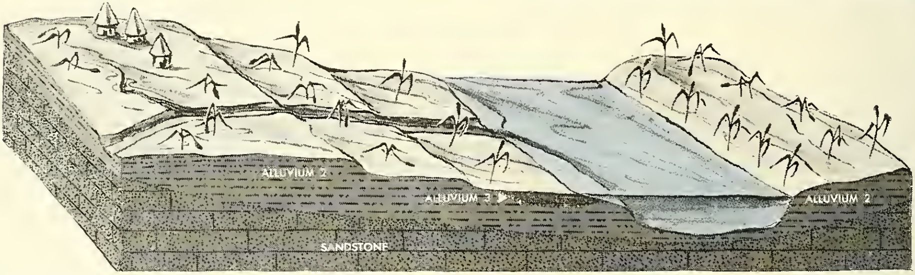
Officer of the Rhodes-Livingstone Institute in Lusaka. My task was to study the human geography of the Valley Tonga over a twelve-month period under the supervision of Dr. Elizabeth Colson, an anthropologist and Senior Research Officer of the Institute. While she studied the structure of Valley Tonga society, I concentrated on their subsistence economy and its adaptation to the environment in which this isolated people made their home.

This region has been considered a famine area ever since it came under the jurisdiction of the British South Africa Company over fifty years ago. Why had it been necessary for Government to send grain into the area practically every other year? In our discussion of the food economy of the people prior to their resettlement, this problem will be frequently mentioned. But, first, a brief description of the physical environment of the region.

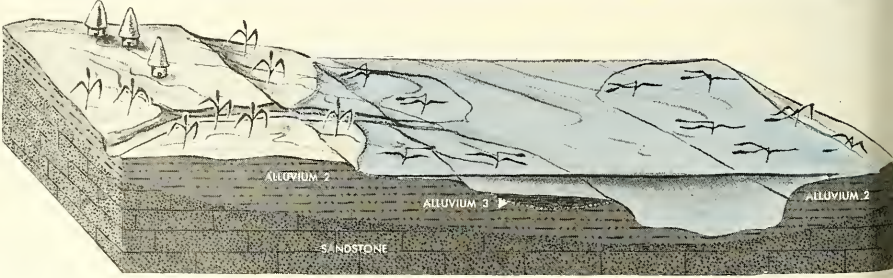
SOME two hundred miles upriver from the dam site in the Kariba Gorge, the Zambezi Valley is again constricted at the exit of the spectacular Batoka Gorge, which, fifty miles further upriver, funnels off the Zambezi at the base of Victoria Falls. Between these two gorges lies the home of practically all the Valley Tonga. In cross section, the geologist H. S. Gair describes this area as a vast, asymmetrical syncline, with an abrupt margin on the Northern Rhodesian side. Structurally, the Valley is composed primarily of Karroo sandstones, occasionally capped with basalt, which, when they lie close to the river's edge,

NEAR ZAMBEZI'S EDGE, a woman feeds her chickens while h
daughter pounds grain for evening meal. Unfinished shelt

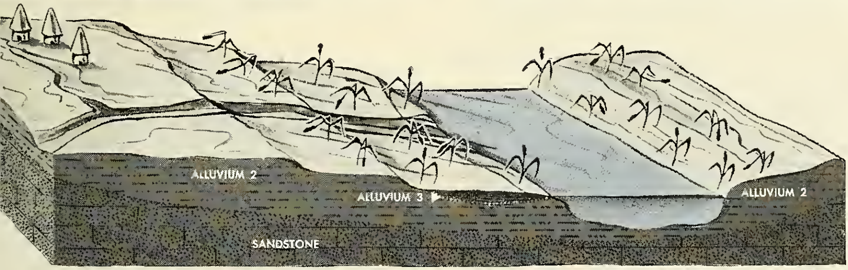
THE SEASON'S PERILS



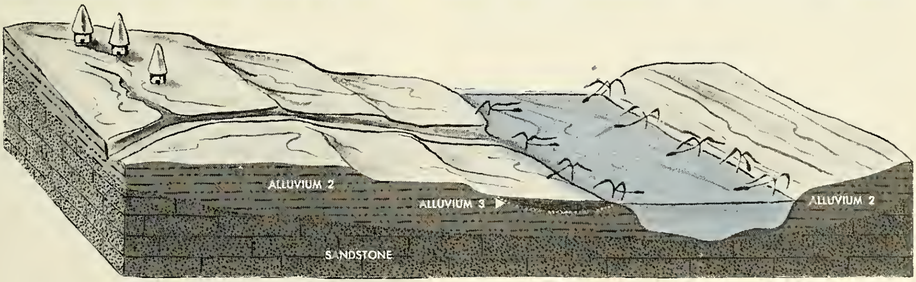
CAUSES OF FAMINE are diagrammed here. *Above*, untimely drought during the rainy season may kill or stunt all crops except those on the recent deposits of alluvium at tributary deltas. A severe early flood, *below*, inundates all alluvi
flats before plants can be harvested, sparing only those o
upland fields. Karroo sandstones underlie alluvial garden



hem is being built so owners can protect the field. Tonga continue agriculture throughout the year, in rainy season and also in dry, when planting follows the water level as it drops and newer alluvia become available for use.


ALLUVIUM 2
ALLUVIUM 3
SANDSTONE
ALLUVIUM 2

ASON HAZARDS are illustrated here. If a river fails in spring because of a lack of rain, there will not gh ground moisture to grow crops in areas back from the water during dry season, *above*. If, on the other hand, river rises prematurely, *below*, crops planted low on banks at end of the dry season may be flooded while still unripe.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SANDSTONE
ALLUVIUM 2

Valley Tonga, despite hard lives, are a cheerful people: group above, dressed in best clothes, are on way to a dance.

Harvested cucumbers, *above*, are valued for their seeds, which, pressed and roasted, are often used in Tonga recipes.

are overlaid with Zambezi alluvia that vary in their a

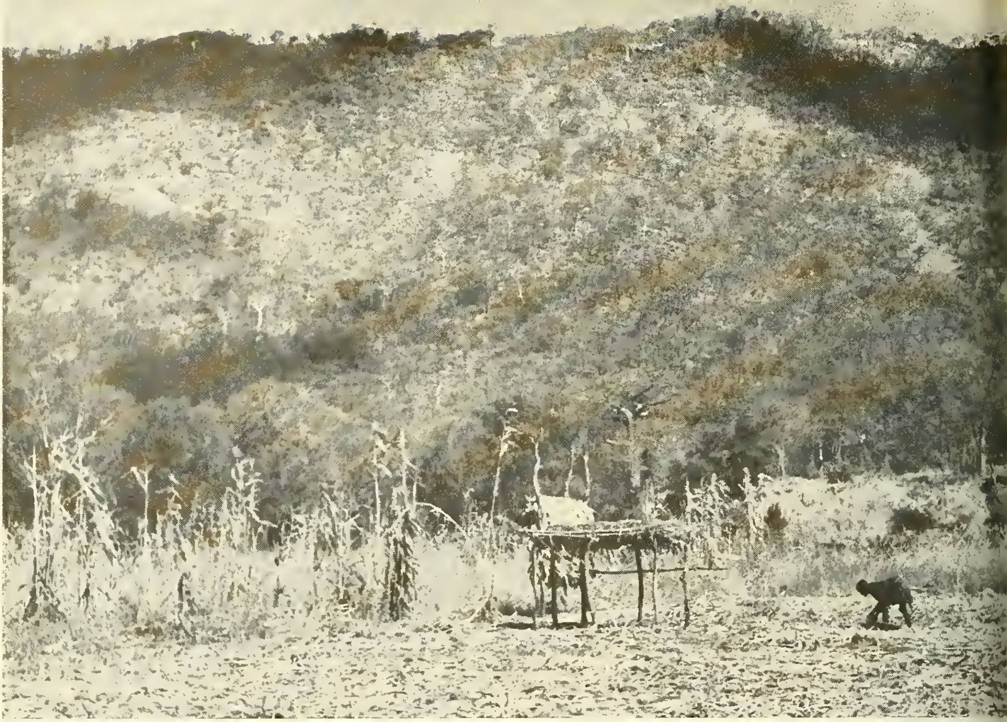
On the Northern Rhodesian side, which carries appro mately two-thirds of the population, Gair divides the Vall into three zones of greatly varying width. The first, clos to the river, is quite flat—with occasional isolated hill and varies in width from under one mile to over ten. Th approximately coincides with the area to be flooded a is the only zone we shall consider in detail. Inland, this zo abuts upon an undulating region of rugged, bush-cover

ne hills—generally running parallel to the river and, s, coming down practically to the water's edge. spectacular at times, these hills may rise several l feet above the Valley floor, cutting off the riverine m a third zone of flat, low-lying country at the base lateau. Through this third zone, tributaries of the i meander, running parallel to the main river until, g round almost 90°, they break through the hills w out onto the flatlands adjacent to the river.

Together, these metal zones vary in width from over twenty-five miles to less than two, so that—taken as a whole —this portion of the Zambezi Valley, from one side of the Plateau to the other, ranges from nearly seventy miles wide to only a fraction of that. Isolation, until recent times, was fostered by the nature of the Plateau margin. Rather than descending abrupt escarpments, the invader must traverse ten or more miles of deeply dissected, broken country before reaching the Valley floor.

Newborn baby provides focus of attention for the Valley Tonga family seen, *above*, relaxing in dry season by garden.

Cattle, *left*, are scarce in the Zambezi Valley because of disease. Their chief use is not for milk, but in plowing.



Kaffir corn is harvested after end of the rainy season in April or May. Grown both in bush gardens and near rivers, kaffir corn is, with millet and maize, one of Valley Tonga' three principal crops. Platform is used for drying the grai

The Valley Tonga are [this present tense refers to 1956-57] subsistence cultivators, living close to the Zambezi and its major tributaries in permanent villages. Their principal crops are bulrush millet (*Pennisetum typhoideum*), kaffir corn (*Sorghum vulgare*), and maize. Population density appears to be determined by the amount of alluvium found along river banks and in the delta areas of certain tributaries. As the amount of alluvium varies considerably because of underlying structure and other factors, population density and village size also vary both along the length of the Zambezi, and on the opposing banks, for large alluvial flats at the mouth of major tributaries are found only on the Northern Rhodesian side. On the basis of age, Dr. Geoffrey Bond has divided the more extensive alluvia into two classes: Alluvium II and Alluvium III. Alluvium III soils are the younger. Where they have been laid down in extensive deposits in tributary deltas, they are the most important agricultural soils along the Zambezi. Adjacent Alluvium II soils vary in fertility. In some localities, they are not suitable for agricultural purposes, supporting little vegetation other than mopane scrub (*Colophospermum mopane*), which is cleared here and there to provide Valley Tonga village sites.

Permanently farming the more fertile alluvia wherever they are annually inundated, the Valley Tonga are able to cultivate two crops per year—one in the rainy season (November-March) and the other during the dry. As the Zambezi begins to drop after its annual flood (April-May), the people follow the receding waters and plant their crops in the alluvium as soon as it becomes sufficiently dry. Throughout the rest of the dry season, the Zambezi continues to drop in its channel, so that—by the followin November, when the rains again are due—the staggere nature of the dry-season plantings is obvious to anyon boating on the river. Near the water's edge, maize seedling are but a few inches high—in contrast to tasseling plant halfway up the bank. The crops planted near the top o the bank, or on the alluvium back from the Zambezi' channel, or in tributary delta areas, have already bee harvested. With the rains, a second crop will be planted i these recently harvested fields, to be harvested when i reaches ripeness the following March.

Given such an agricultural setup, why did periodi famines occur, especially when the population wa smaller than it is now? While drought during the rain season is the major cause of famine, a less obvious caus is tied up with the annual regime of the Zambezi. Althoug river flow fluctuates during any twelve-month period according to a definite pattern, the water level can var tremendously from year to year during certain critica months. For example, in March, 1948, Zambezi flow recorded at Livingstone was 147,100 cubic feet per second The following March it was only 29,300 c.f.s. So far a the Valley Tonga are concerned, such variation can mea the difference between a good harvest and virtually n harvest at all. If the river floods in early March—instead o in April or May—it will inundate the delta areas an alluvial flats inland from the main channel before mos of the rainy season maize can be harvested. Up to eight per cent of the crop can be taken by the water in this way If this unseasonal flooding happens in two successive years

TED GRAIN is being spread on platform to dry, *above,* ll be stored in village granary. Abundance of crops may vary sharply from village to village: before the British rule, food-rich villages were often attacked by hungry ones.

the Valley Tonga find themselves in a serious position.

On the other hand, if the river fails to rise appreciably in March, April, and May—because of insufficient local and upriver rains—there will not be sufficient ground moisture to grow dry-season maize in the alluvial areas back from the river or even along the top of its primary channel. A similar predicament can occur if, after the flood season, the river drops too rapidly, leaving dry-season crops high and dry (the mean maximum annual temperature throughout the Valley is close to 90° F.). Finally, if the river begins to rise appreciably in December—rather than in January-February—because of heavy early rains, crops planted low on the banks during the latter portion of the dry season may be flooded before they can be harvested. In any twelve-month period, up to three of these four possibilities can occur—which means a bad year indeed.

Thus the fertility of Zambezi alluvia and the river's annual pattern enables the Valley Tonga to plant two crops a year, although an extreme variation in river flow during the same months in different years may keep the people from harvesting either or both of these crops.

In some years, the crops may be under three feet of water at harvest time; in others, they may scorch because of insufficient moisture. Although the seasonal fluctuation of the Zambezi is the basis for the type of agricultural economy the Valley Tonga practice, at the same time its variability imposes severe limitations upon this economy

As an escape valve, the people also practice a form o shifting cultivation in the bush during the rainy season. In the past, this has been largely limited to a narrow band of land along the main watercourses (including the Zambezi) just back from the alluvial zone. Within the past fifteen years, however, the villagers have begun to cultivate sizable gardens (called *matemwa*) well back in the bush often a mile or more from the villages and running water Harvests of bulrush millet here appear to be good even during years of low rainfall, so long as the sandy loams—of Karroo origin—have not been exhausted. Granted this one wonders why the people did not grow more millet in the bush as a famine check in the past, especially since aerial photographs reveal sizable areas of suitable land Although no people utilize all natural resources within their environment, people with subsistence economies, in general, are acutely aware of those aspects of their habitat that relate to their main occupations—whether gathering hunting, fishing, pastoralism, or agriculture. If, as in the case of Valley Tonga agriculture, large tracts of land are unused at certain points in time, there are probably excellent reasons, both environmental and cultural, for this

ock—here including sheep and goats—is a threat to ture, must be closely herded to prevent crop damage.

Much of the low-lying bush area back from the Zambezi is mopane woodland, which constitutes perhaps the best browse for big game in low veld areas. Although, today, much of the game has been shot off or driven out of the mopane into isolated thicket areas, elephants still periodically devastate Tonga gardens. In the past—when the population was smaller (it appears to have doubled in the past half-century), and guns rare—*matemwa* gardens would have been very vulnerable. Moreover, in many suitable areas, if little rain falls in February or March, lack of drinking water can be a hardship to bush cultivators.

Irregular rainfall, however, has implications of even greater importance. Since total rainfall varies between adjacent areas within the Middle Zambezi Valley not only in any one year, but also in the same month and on the same day, rainy season harvests—which are dependent on rainfall rather than on ground moisture from major waterways—may be excellent in one area, but insufficient in another area only twenty miles away.

This factor alone may have had much to do with the pattern of raiding within the Valley. Prior to *Pax Britannica*, clusters of villages were drawn together into geographical units—called *chisi*—which in the past formed a basis for certain political activities. When famine affected the villages of one *chisi*, for example, its male inhabitants might raid villages in another *chisi* where a good harvest was stored away. If people had cultivated isolated gardens out in the bush in those days, they would have been far more vulnerable to raids than in their regular gardens, which lay comfortably close to the rivers and villages.

Of course, raiding ceased in the Valley after the turn of the century, so that this factor would no longer be a deterrent to bush cultivation. In those early days of British administration, however, families—and even whole villages—were still accustomed to move up to the Northern Rhodesian Plateau when famine conditions became un-

otami scarecrows—straw and gourd figures, *above*— the river garden. Owners construct shelters on stilts, *right*, and may watch the whole night to frighten hippos and occasionally even elephants away from the cultivated fields.

bearable. This northerly movement of people out of the Valley was an established historical phenomenon, but in recent years it has diminished because of overpopulation in Plateau districts. Population, however, had also increased in the Valley, where—because of garden fragmentation and overcultivation—there was no longer sufficient alluvial land for many families. There was no apparent alternative now to pushing out into the bush where human raiders and animal foragers no longer were the limiting factors they had been in previous decades.

Sparking the tremendous development of *matemwa* gardens on the Northern Rhodesian side of the Valley in the last ten years was a Government grain tax placed on bulrush millet, which obligated each family to deliver a fixed quantity to special granaries in chiefs' villages. As a famine relief measure, this was most successful as it practically forced families to supplement their usual gardens with new ones in the bush. While the tax was only imposed for a few years, it speeded a process that had just begun to develop (aerial photographs indicate that enterprising individuals had begun to cultivate *matemwa* gardens even *before* the grain tax was introduced).

Today, over large areas, bulrush millet has actually become a more important crop than maize or kaffir corn—which are best grown close to the rivers in alluvial soils. As millet harvests have increased, less acreage of other crops is being planted in the poorer alluvia back from the rivers, although—because of the *matemwa*—the total of all crops per family appears to be greater during the five-year period 1951-56 than ever before. Even with a larger population, the need for famine relief was lessened during these years. Of course many other factors enter into this picture but the development of *matemwa* gardens appears to be the most important.

Unfortunately for the Valley Tonga, time cannot be stopped. Already some *matemwa* gardens have been continually cultivated for nearly ten years. While harvests are still remarkably good, it is doubtful that soil fertility will last much longer. Sooner, rather than later, the people would have to clear new *matemwa* and allow old gardens to regenerate—a process probably requiring at least twenty years. After ten years of bush clearing, however, little suitable land is left today for future gardens. In fact, some young men—returning from several years' labor in the urban centers on the Plateau—must now clear gardens in areas cut off from their villages during the rainy season by major watercourses in flood.

As for those alluvial soils finally being rested because of increased millet production, their fallowing was long overdue. While the food shortages that reappeared in certain areas along the Zambezi during 1957-58 were primarily correlated with record March floods during two successive years (*matemwa* gardens, alone, cannot support the existing population), those conditions also reflected the exhaustion of sizable areas of alluvium, coupled with insufficient land for *matemwa* gardens. The implications here are that even without the Kariba Dam Project, Government would have been forced to resettle many of the Valley Tonga within the next fifteen to twenty years—primarily because of the exhaustion of the soil.

Viewed within the context of their limited technology, the current Valley Tonga agricultural practices are, in general, well adapted to their environment, although, from the European viewpoint, many profitable innovations could be introduced. While some of these would involve technological improvements that the Africans are as yet in no position to receive, others do not.

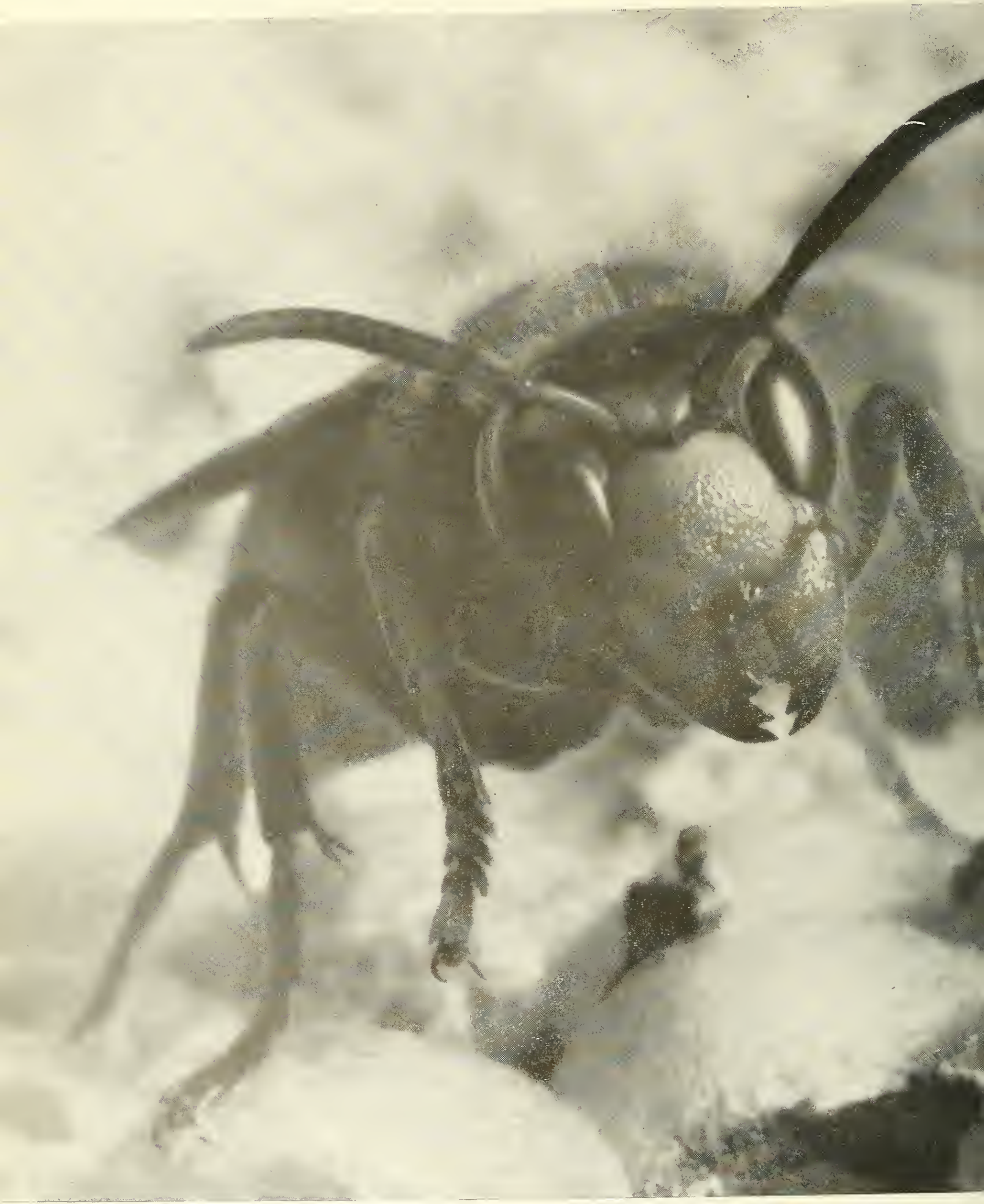
Perhaps the most glaring of these inadequacies in the Valley Tonga system of agriculture is the complete absence of food crop irrigation. Although the people occasionally water tobacco seedlings, food crops are allowed to burn up high on the banks of the Zambezi while thousands of acre-feet flow by within a hundred paces. Even with present

Wild grasses are harvested during February at the height of rainy season, are a major food source during famine years.

gy, river gardens could be watered by using the
s with which the people carry cooking and drink-
r to the village. There is no sufficient explanation
situation; it is just one of the imponderables that
e found in any study of human populations.

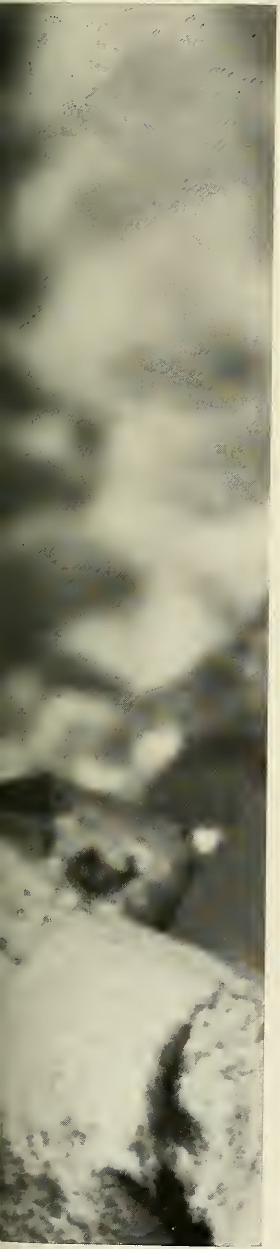
R unexploited possibilities within the knowledge
the people at least lend themselves to tentative
ons. Although no systematic crop rotation or
g is practiced, these are techniques possibly with-
rent advantage to cultivators of alluvial soils.
ny one generation, soil exhaustion would be so
s to make the development of specific remedies to
or restore fertility apparently pointless.
ver, if the Zambezi sticks to its annual pattern without marked fluctuations, alluvial crops often will be sufficient, while no amount of fertilization (whose benefits the people recognize), for example, would help crops that are inundated. Bush gardens, of course, would benefit from such techniques, but agricultural practices among the Valley Tonga are practically the same, regardless of soil type. The pattern developed for riverside cultivation is transferred intact to the bush, where sandy loams are cultivated as if they were alluvia. Perhaps the most important point here is that while the people do not carry out some practices that they ought to (and that they could, given Tonga technology), most of their actual techniques are quite well adjusted to local conditions. (The second half of Mr. Scudder's case study in human geography will appear in the May, 1960, issue of NATURAL HISTORY).

Hornet workers' role



Foundation of hornets' social organization is the female, *above*. Brood-rearing and food-gathering are her principal activities. Here a female *Vespa crabro* menaces an i
ready to attack in defense of the comb on which she

to feed and to be fed



hang in papery cells, *right*. Puls-
eart tube shows through skin.

Brood-rearing involves two-way exchange

By Fritz Schremmer

BROOD-REARING and its concomitant food-gathering present some of the most remarkable aspects of a hornet—in this case, *Vespa crabro*—community's activities.

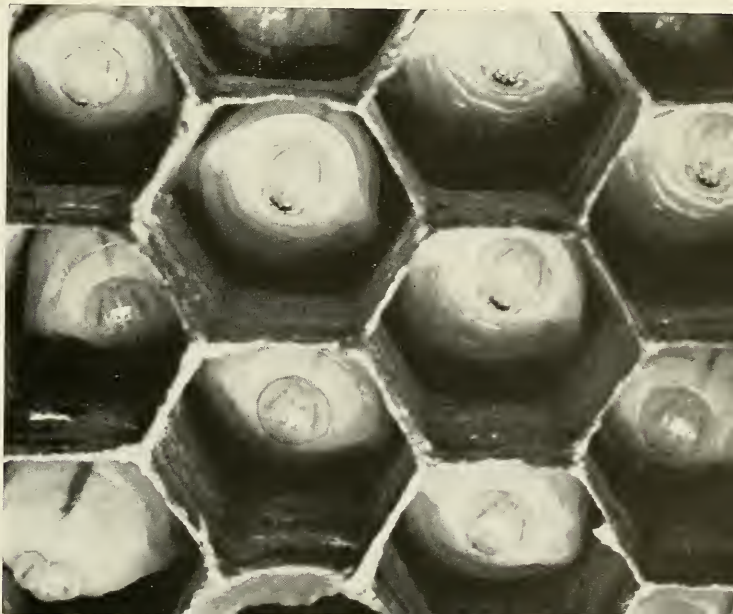
In rearing the brood, for instance, a constant nest temperature is maintained. The larvae seem to thrive best at about 86° F., and experiments indicate that this temperature changes by no more than two to four degrees during the entire summer brood-time, although outside temperatures may vary by as much as 20° F. In cold weather, hornets produce heat by burning their bodies' nutritive substances.

The number of winged inhabitants in a hornet's nest may often exceed 1,000 individuals. In addition, the colony may contain more than 200 larvae. The latter stay neatly arranged in their hexagonal cells, their heads all pointing toward the center of the comb—a convenient arrangement for the food-supplying adults.

As soon as a larva is fully grown, it begins to close its cell with a convex covering that consists of secreted threads that assume a feltlike texture. Within this closed cell, the larva casts off its skin and changes into a white pupa, in which can be recognized the embryonic limbs and body segments of the adult hornet. After a period of fourteen to eighteen days, the pupal skin is also cast, but the insect remains in the cell for one or two more days, as an imago, preparing to hatch. It then eats slowly through the cell covering, and the adult hornet emerges, prepared to begin contributing food to other residents of the nest—a highly intricate, co-operative process.

FLIES, caterpillars, and many other insects are a hornet's normal prey. These are carefully chewed: the fluids are swallowed and stored in the hornet's crop for distribution to the community, while the finely ground flesh is formed into a ball and carried home between the mandibles.

On arrival back at the nest, the working hornet—a female, as are all



rkers—is immediately sur- l by her sisters, who beg for 'he collector bends sideways, er mandibles, and regurgitates of her crop contents, which ɔ her broad, slightly protrud- gue, and is quickly licked up others. The collector-hornet ɔnly the barest minimum of r herself. If there are many insects in the nest, the collec- ɔp is quickly emptied, and she ner search for food. If her crop ied slowly, or if it remains illed, she stays in the nest until d is consumed.

ɜ sisters who were fed by the r withdraw into the interior of ., where they in turn pass on the food they have received. Thus, each "beggar" becomes a donor. No wonder the crop of social insects that exhibit this behavior has been termed the "social stomach."

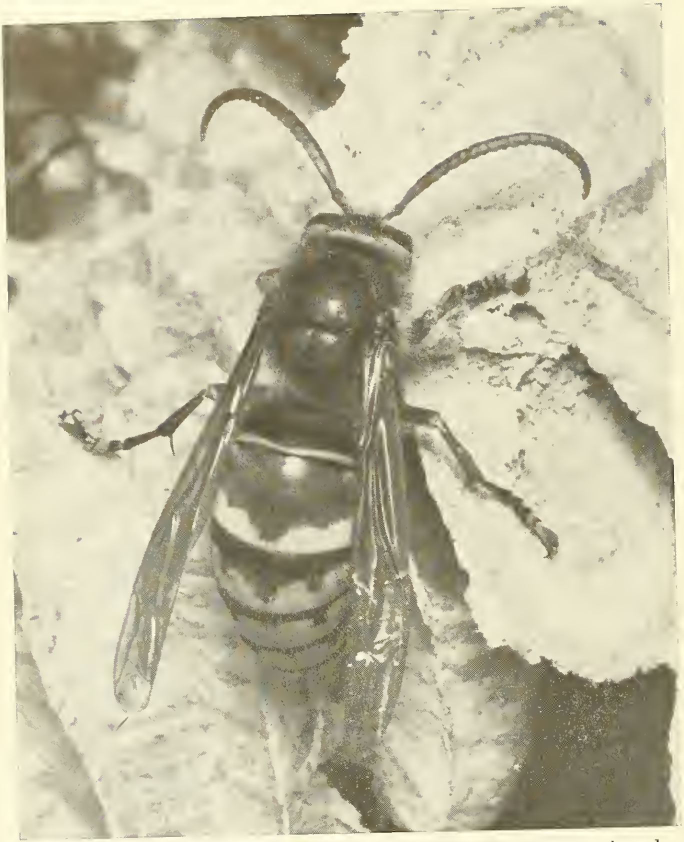
NEWLY hatched larvae are fed nutritive glandular secretions from worker-hornets' bodies, while the somewhat older larvae are fed primarily with insect flesh. A collector-hornet bends down into a cell containing a larva, which lifts its head, opens its mandibles wide, and emits a drop of water-clear saliva that smears the food pellet, making it moist and slippery, and thus easy to swallow.

Surprisingly, even when the collector does *not* offer food, the larva reacts in the same manner. In this case, however, the saliva is imbibed by the adult

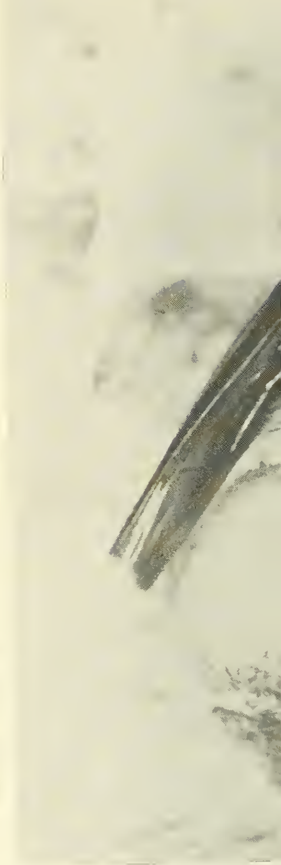
FULLY DEVELOPED, young hornet chews through its umbrella-like cell covering.

HORNET both feeds larva, *left,* and extracts saliva from ɜxchange of nourishment known as "trophallaxis."

FRESHLY EMERGED from their cells, young hornets, *above,* relax at the edge of their comb after cleaning themselves.



HORN-SHAPED ANTENNAE identify male hornet, *above*. Males, which appear at the summer's end, are not workers, but have only single function—procreation.



hornet. If the larva does not secrete, it is urged to do so in an unequivocal manner; the adult seizes the larva's head between her mandibles, draws it slightly toward herself, then pushes it violently back into its cell until the larva produces the saliva.

THE fact that adult animals are fed by larval saliva, and that they eagerly demand it, is one of the strangest phenomena in the social life of the hymenoptera. W. M. Wheeler, the late Harvard entomologist, called this kind of reciprocal feeding "trophallaxis," and hypothesized that it is one of the bases of the life of these insects, actually preventing disintegration of the social organization. Larval saliva is both nutritive and stimulating, and induces the workers to nurse the brood.

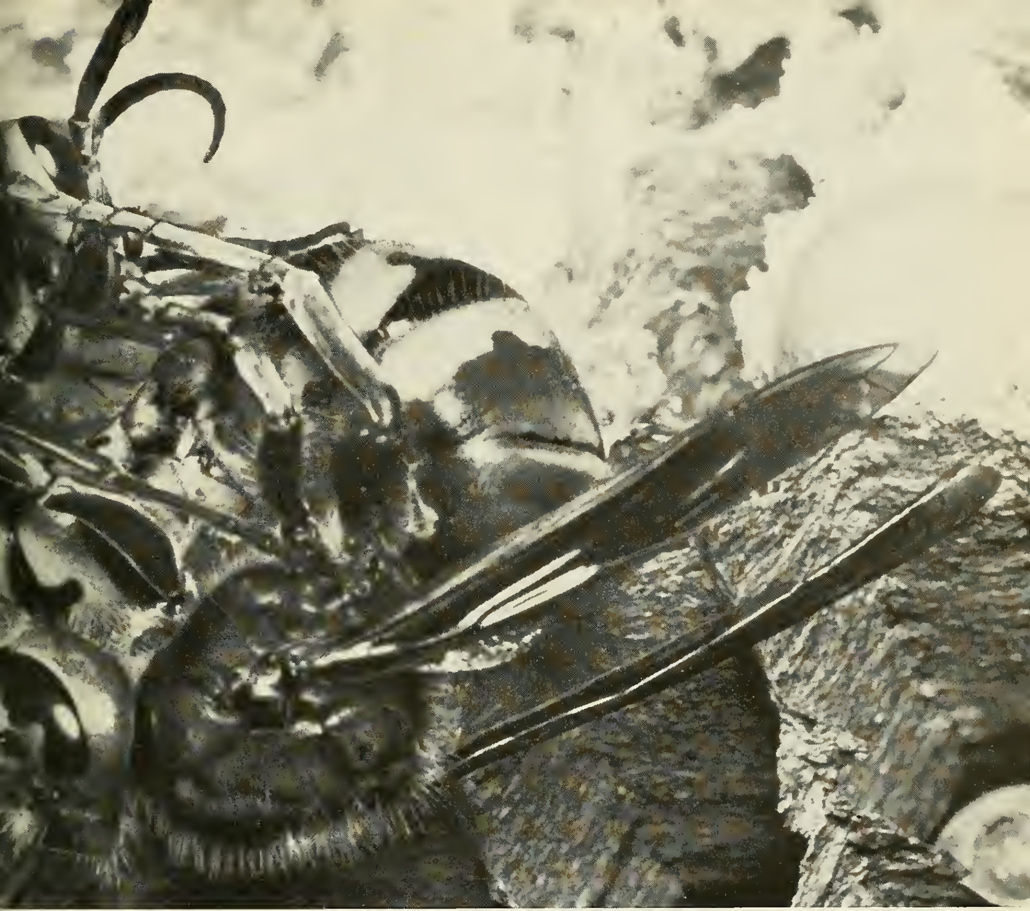
Another aspect of reciprocal feeding can be found in the licking phenomenon. Sometimes female hornets have been seen licking each other with such vigor, mandibles agape, that they appear to be fighting. The areas most licked are the neck and the dorsal side of the abdomen.

This licking has little or nothing to do with any social "cleaning" drive. Rather, it serves to obtain a stimulating substance secreted by the skin. Research concerning the nature of this material is still being conducted, and the only positive statement that can now be made is that mutual licking plays a vital role in regulating the social life of the hornet.

The male hornet is not a worker:
his function is purely propa
Immediately after copulation, t
tilized female pursues the male,
and stinging him. In one obser
a male fell motionless to the
shortly after being stung betw
dominal segments. One of his a
was bitten off, and the right wi
broken at the root. After twen
utes, only the terminal segm
his legs showed weak and co
movements: his death occurre
two hours later (see photo, *rig*

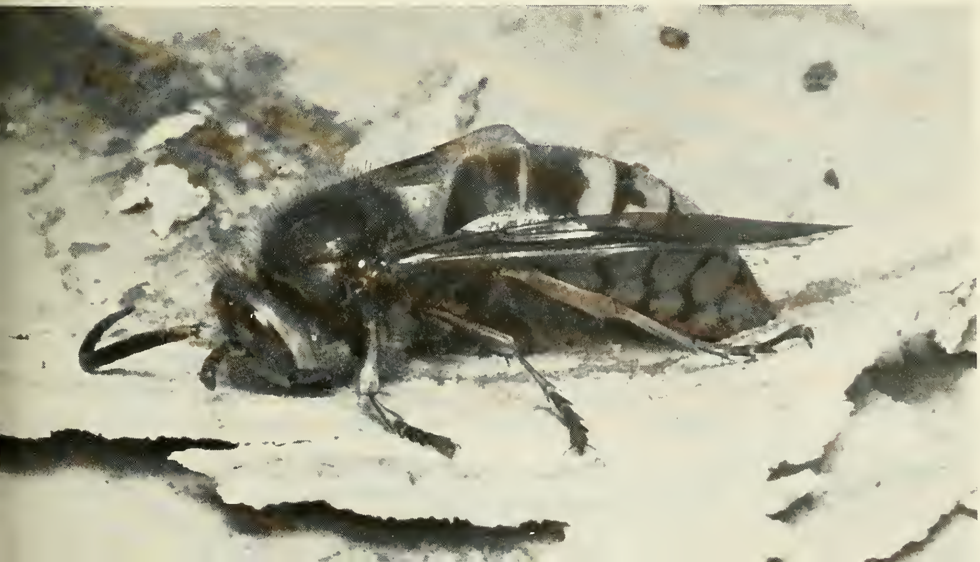
SUCH maltreatment of a mal
unique. Males have been f
study cages, with their heads se
from their bodies. Others ha
so nibbled upon that pieces of t
or the thorax were missing. I
obvious that these victims h
tributed to the nourishment
equally ill-fated brother's o

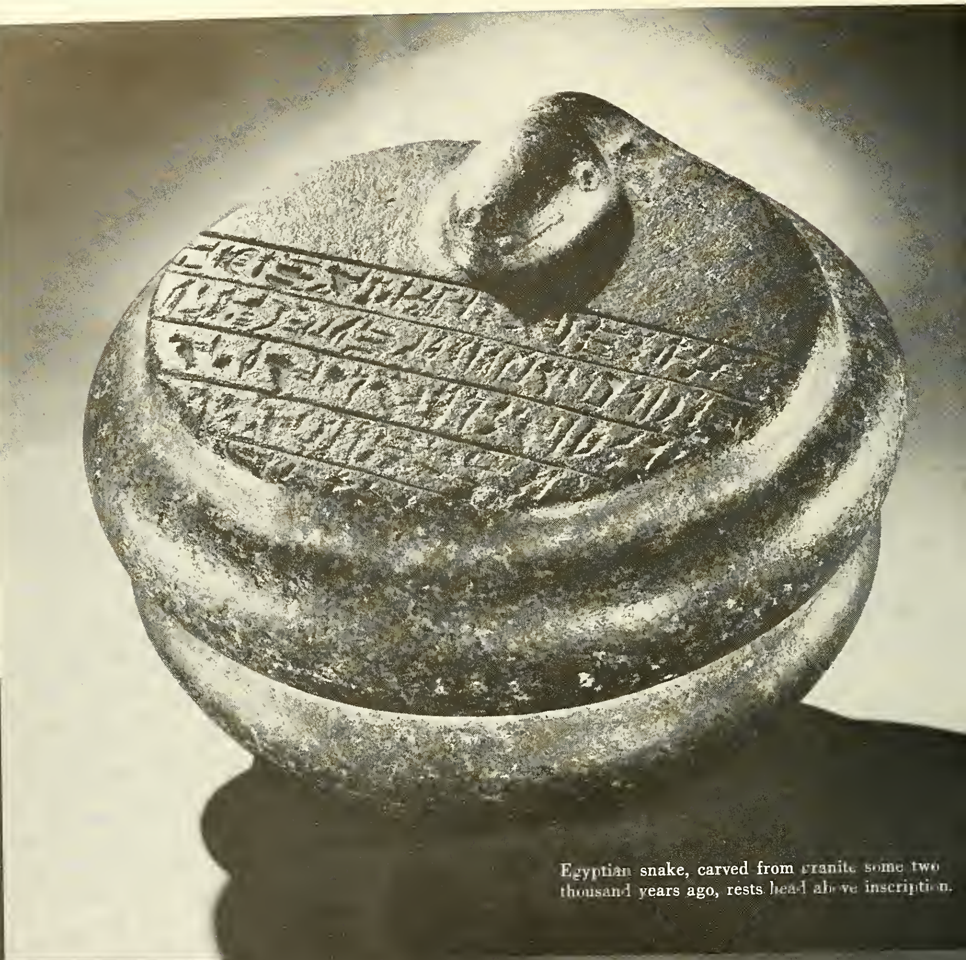
DR. SCHREMMER, an entomologist who is associated with the University of Vienna's Zoological Institute, here makes his debut in NATURAL HISTORY as both a writer and a photographer.



ULATION OF HORNETS is rarely observed. Male's curved nnae are at upper left, *above*, female's at lower left.

DYING MALE, *below*, is paralyzed by sting of fertilized female, who also bit off left antenna and broke right wing.





Egyptian snake, carved from granite some two thousand years ago, rests head above inscription.

Sculptured Animals

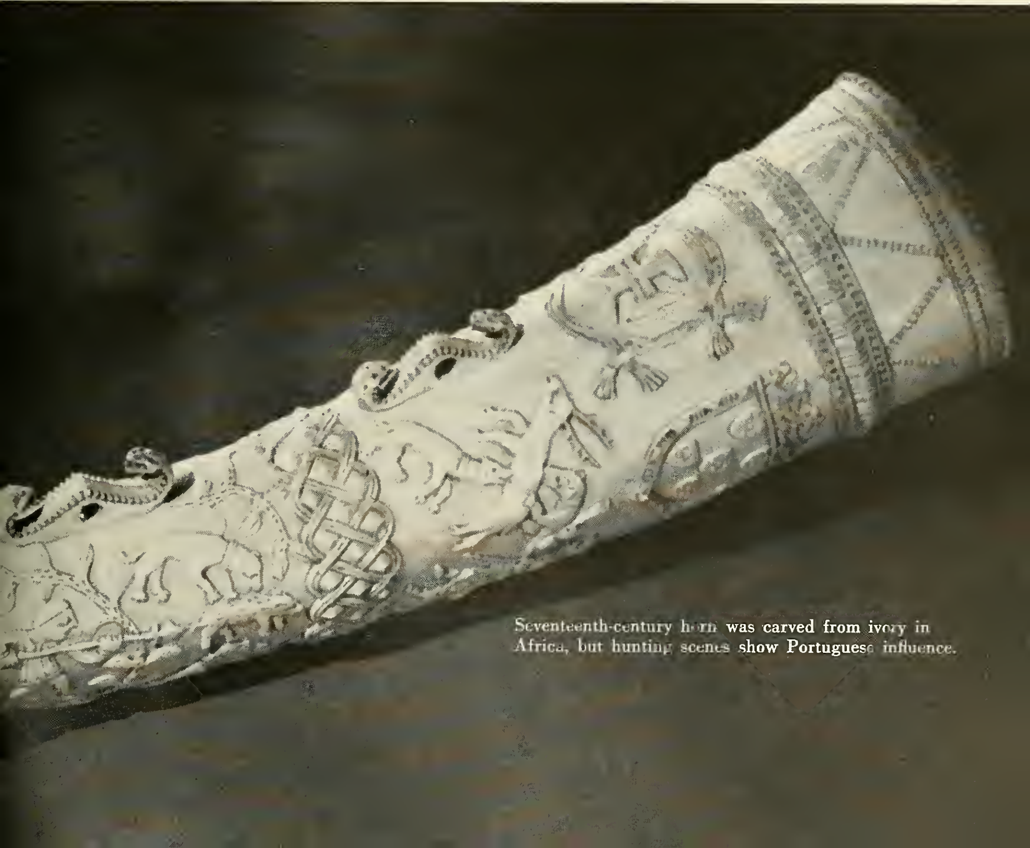
easts, birds, mythical creatures have been immortalized in art

Photographs by Lee Boltin

HE CONTEMPORARY AMERICAN, accustomed to seeing his animals curled by the hearth or peering demurely a calendar on the wall, sometimes forgets that animals played a role in other cultures important enough to mmortalized in major and often exquisite works of art. ted for their flesh—their skins, teeth, and hair used for ing and other essentials of life—animals were so neces- a part of early and primitive societies that they were worshiped as deities, and sometimes even considered odiments of human ancestor spirits.

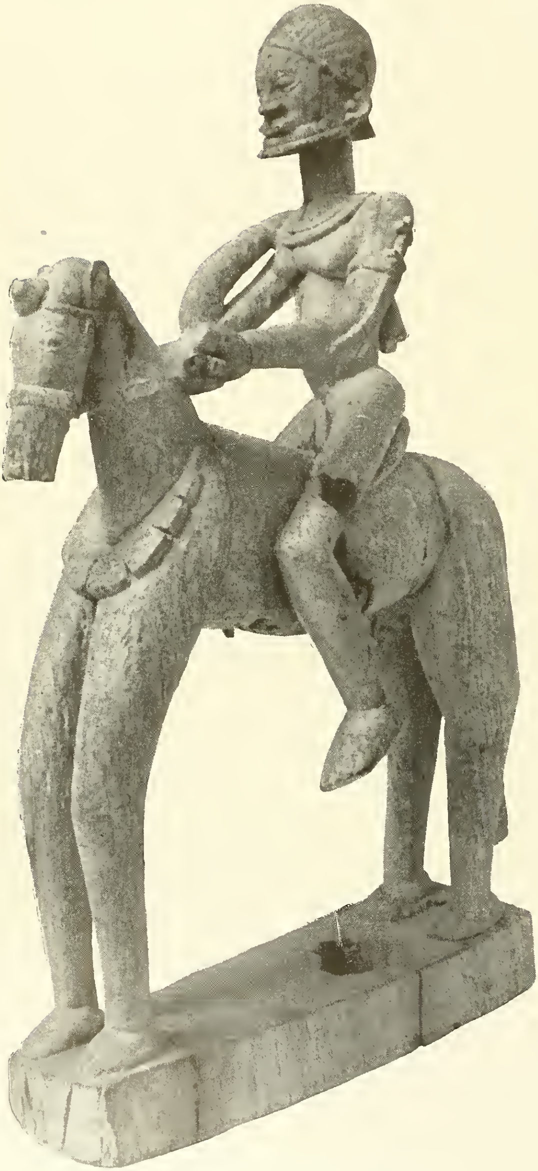
he sculpture on these pages, from the collection assem- by Jay Leff and recently exhibited at the Carnegie itute in Pittsburgh, gives an indication not only of the ortance of animals in a wide variety of societies but of wealth of styles and materials in which they were rep- nted. People as diverse as the ancient Chinese and the ewell mound-builders portrayed them naturalistically, in bold sculptural forms. In contrast, the Bambara, a group of tribes still living in the Western Sudan, carve their *tji wara*, or antelope headpieces, in a stylized fashion in which the empty spaces are as important to the sculpture as the carving itself. Stone, wood, metal, and such animal products as horn, bone, ivory, and shell have been employed. Birds, snakes, horses, lions, and every other beast known to man—including some fanciful hybrids produced by the artist's fertile imagination—all have been fair game.

To carve a beautiful object for beauty's sake alone was a concept almost unknown to artists of these cultures. As a result, most of the bowls, boxes, horns, rattles, masks, and figures shown here were either used as ceremonial objects or as household utensils. But disparate though these objects and the ideas that produced them may be, there is one unifying factor. Each creation is the work of a skilled artist whose standard of beauty was extraordinarily high.

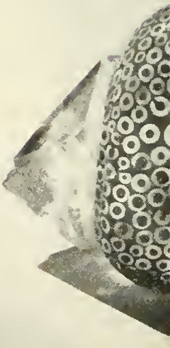


Seventeenth-century horn was carved from ivory in Africa, but hunting scenes show Portuguese influence.

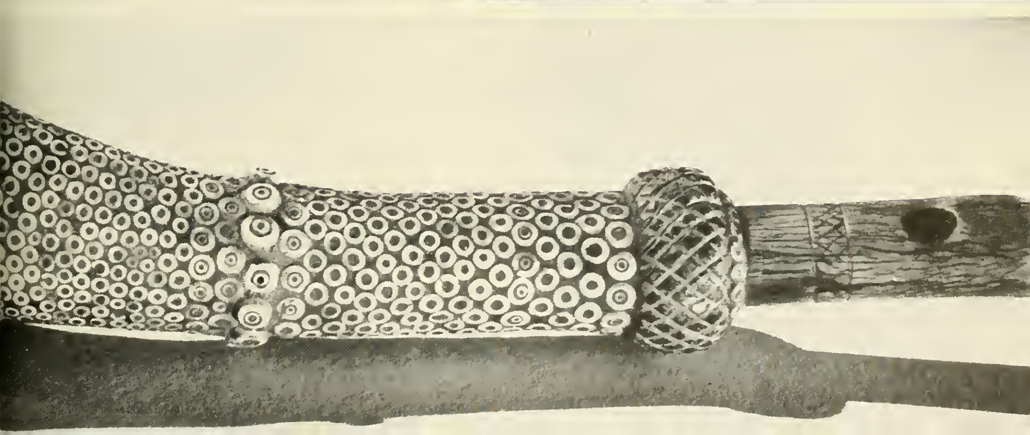
Bronze tiger, incised with gold, was given a belligerent pose by its Chinese sculptor, during the Han Dynasty.

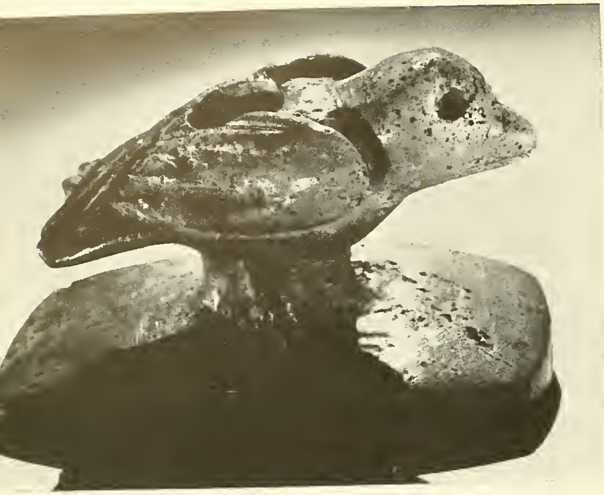


Less than naturalistic horse supports a Dogon rider of the French Sudan, carved in eighteenth century.



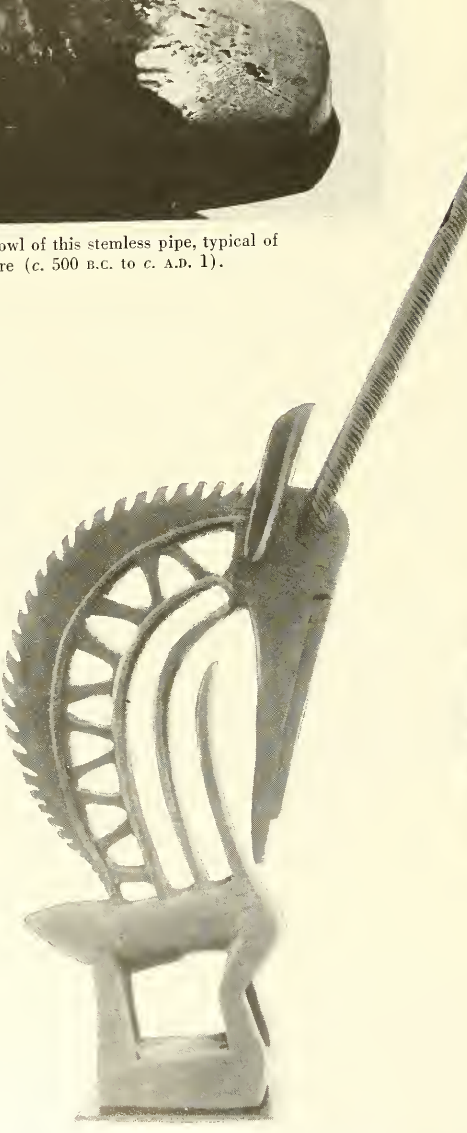
Heavily inlaid flute of steatite, precontact work of California's Chumash tribe, may mimic bird's head.



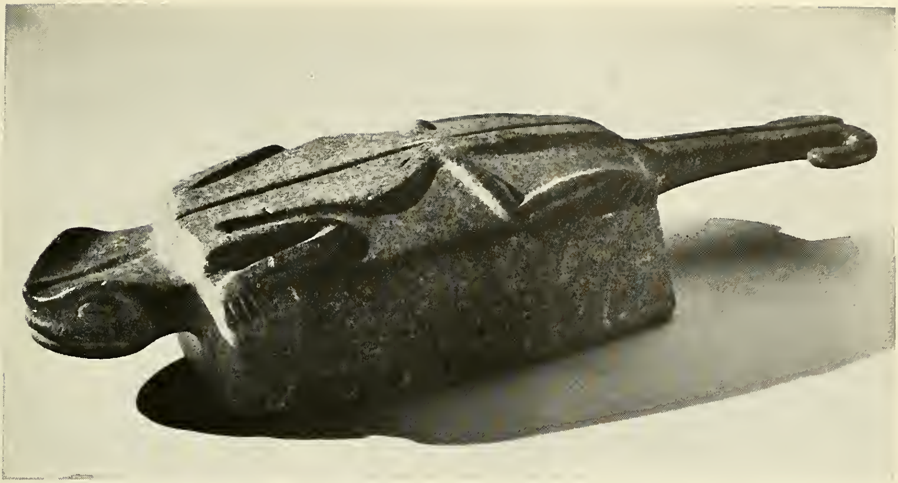


Perching bird forms bowl of this stemless pipe, typical of Ohio's Hopewell culture (*c.* 500 B.C. to *c.* A.D. 1).

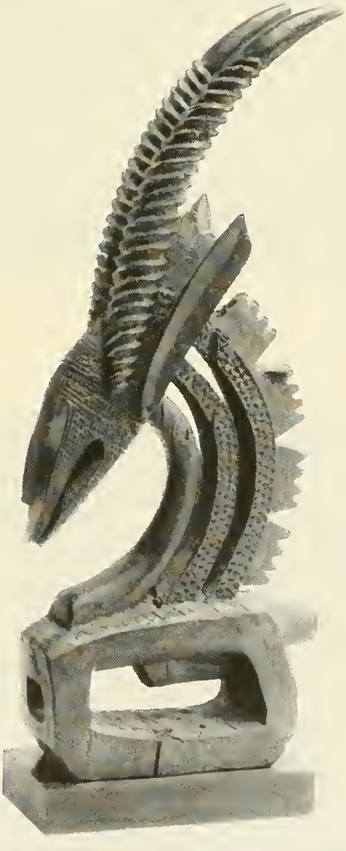
Animal-headed figure bestrides this foot-lo
double flute from San Andrés Tuxtla, in Mexi



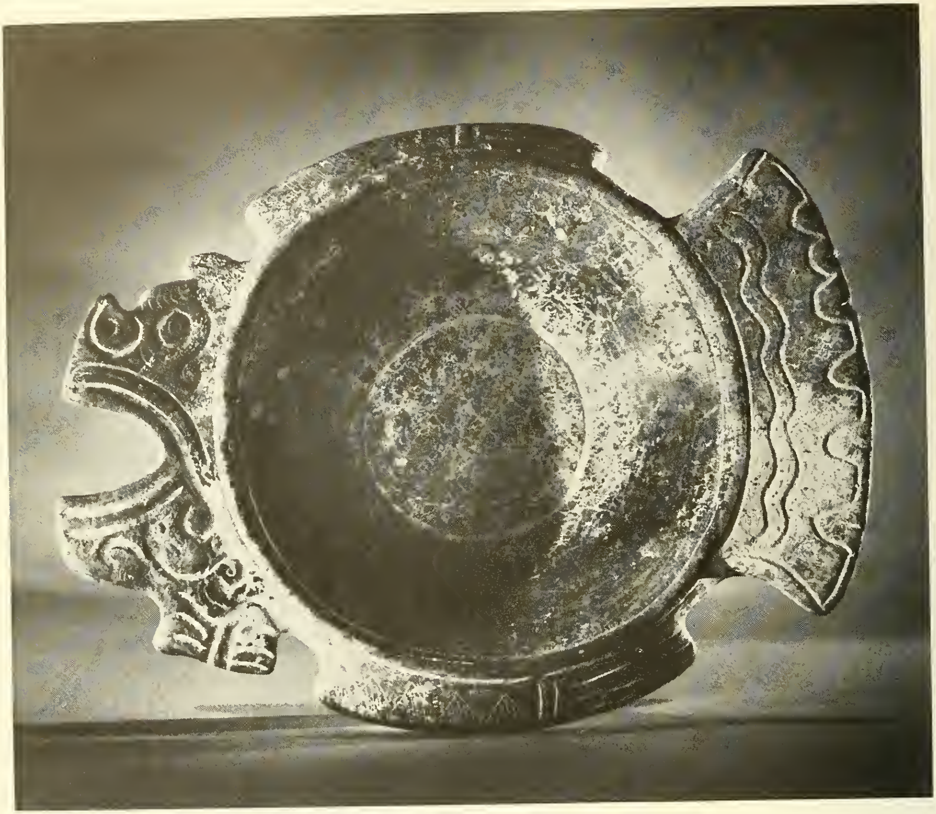
Headdress, in form of abstract antelope, is an example of modern work by Bambara of the French Sudan.



Stylized lizard, boldly carved from stone, was made during the first millennium B.C. in Mexico's Guerrero area.

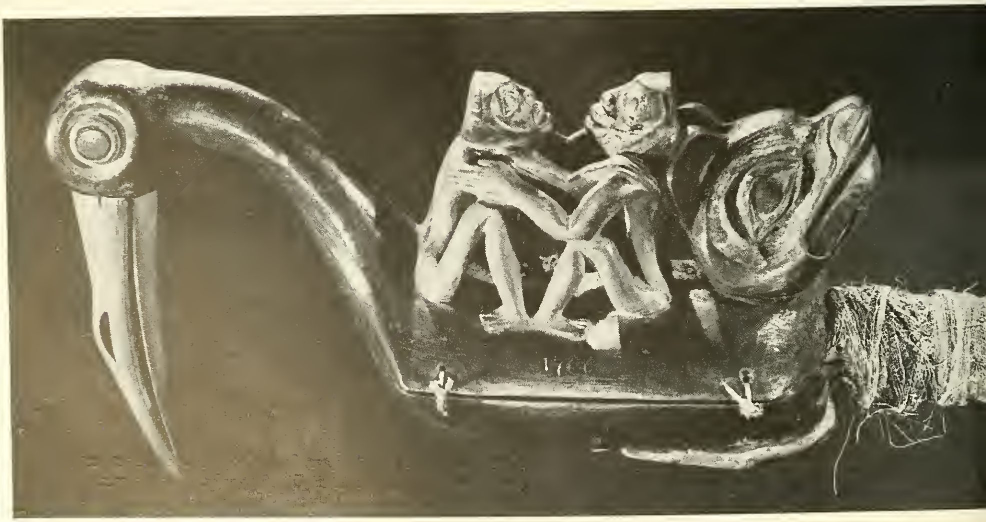


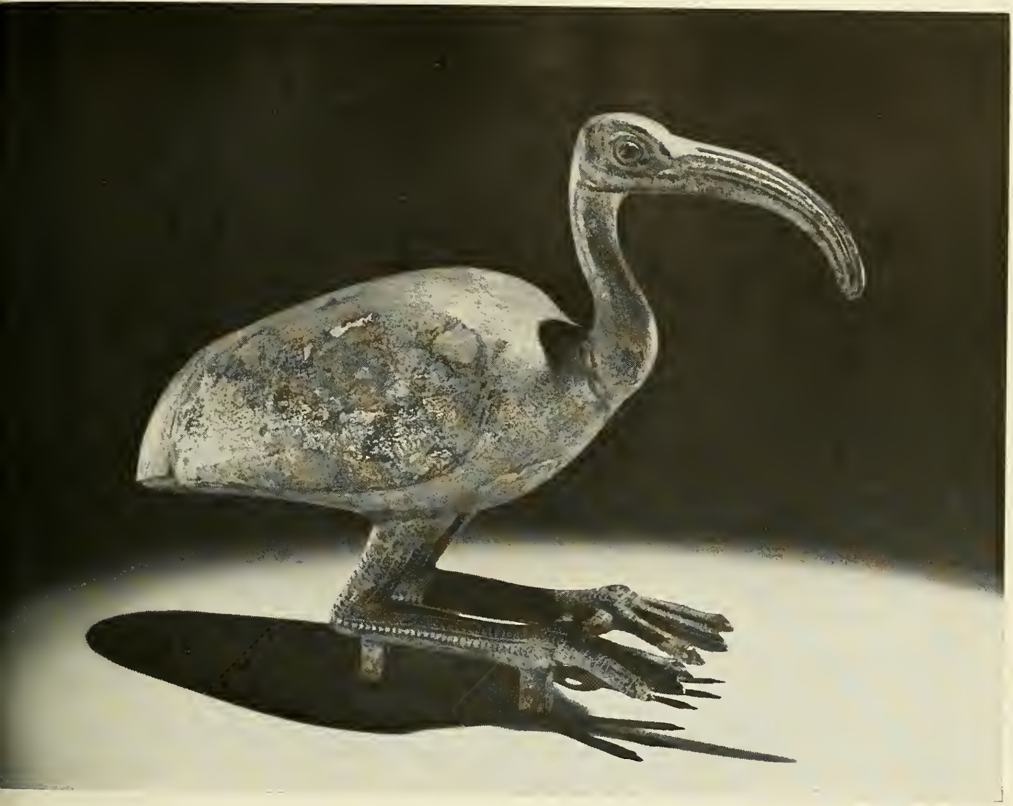
Realistic horns top this antelope headdress of nineteenth-century date, another example of Bambara woodwork.



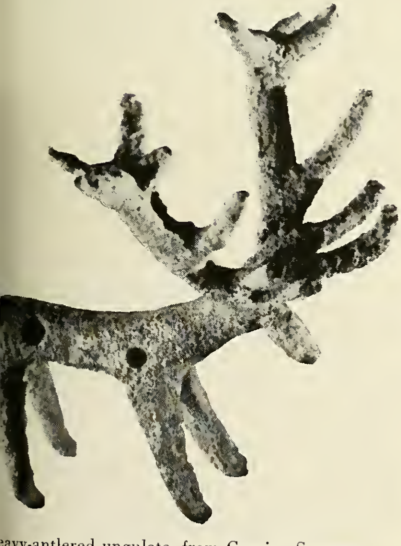
Olmec plate, *above*, from Mexico, has fish's shape.

Northwest Coast rattle shows bird's and bear's heads.



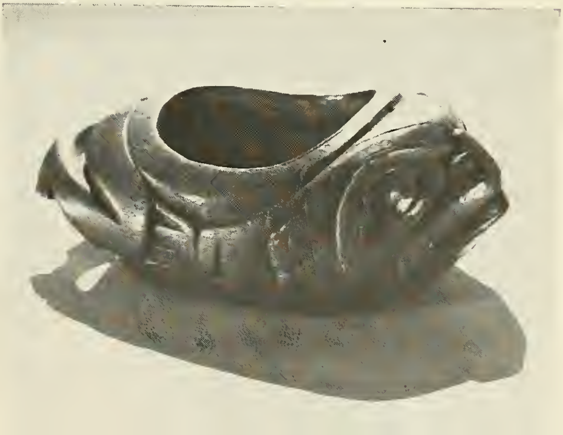


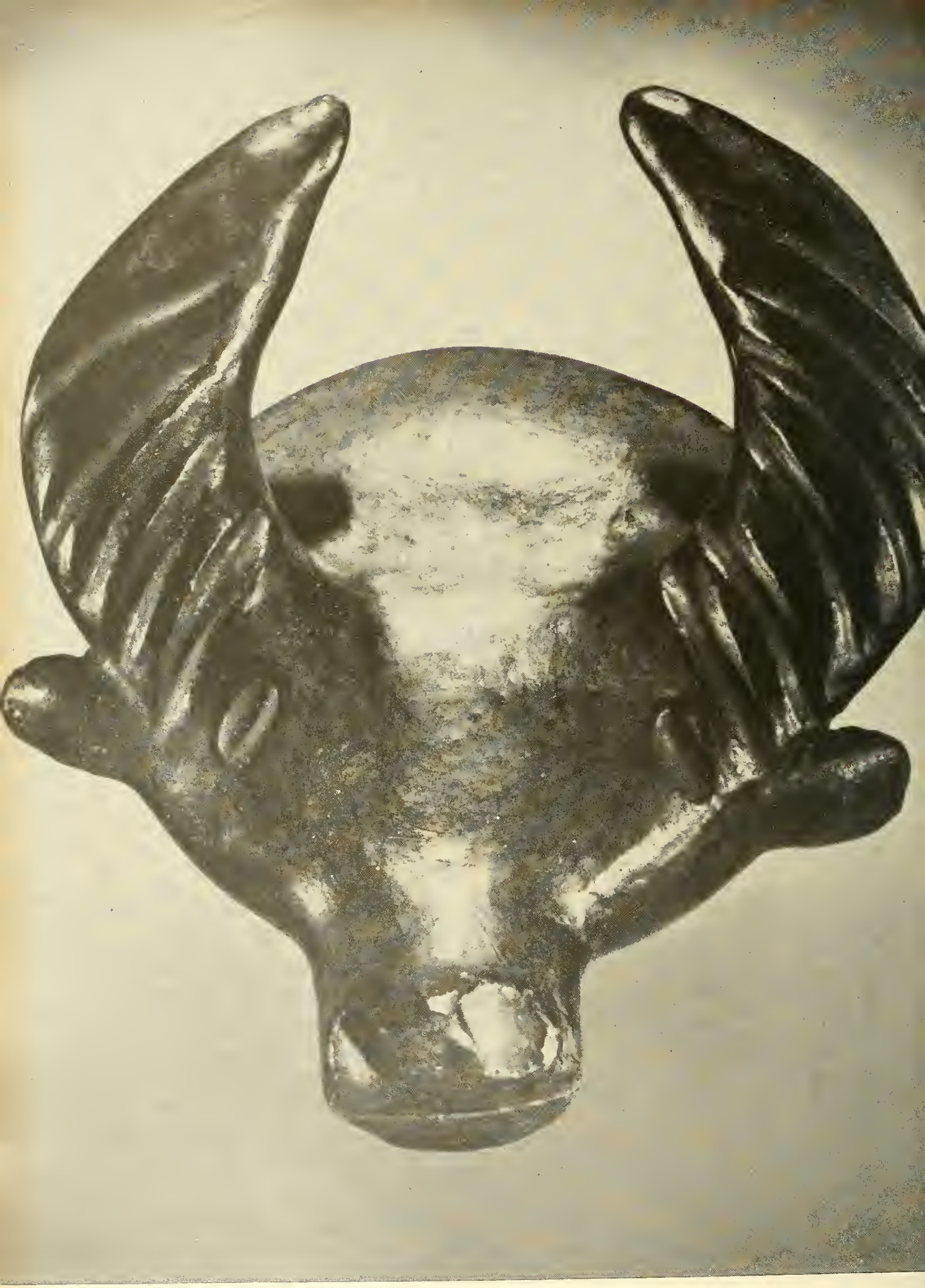
Egyptian ibis, a sacred bird, was wrought of bronze and wood in the third century B.C. Eye is inset of obsidian.



eavy-antlered ungulate, from Caspian Sea area, s cast in bronze over three millennia ago.

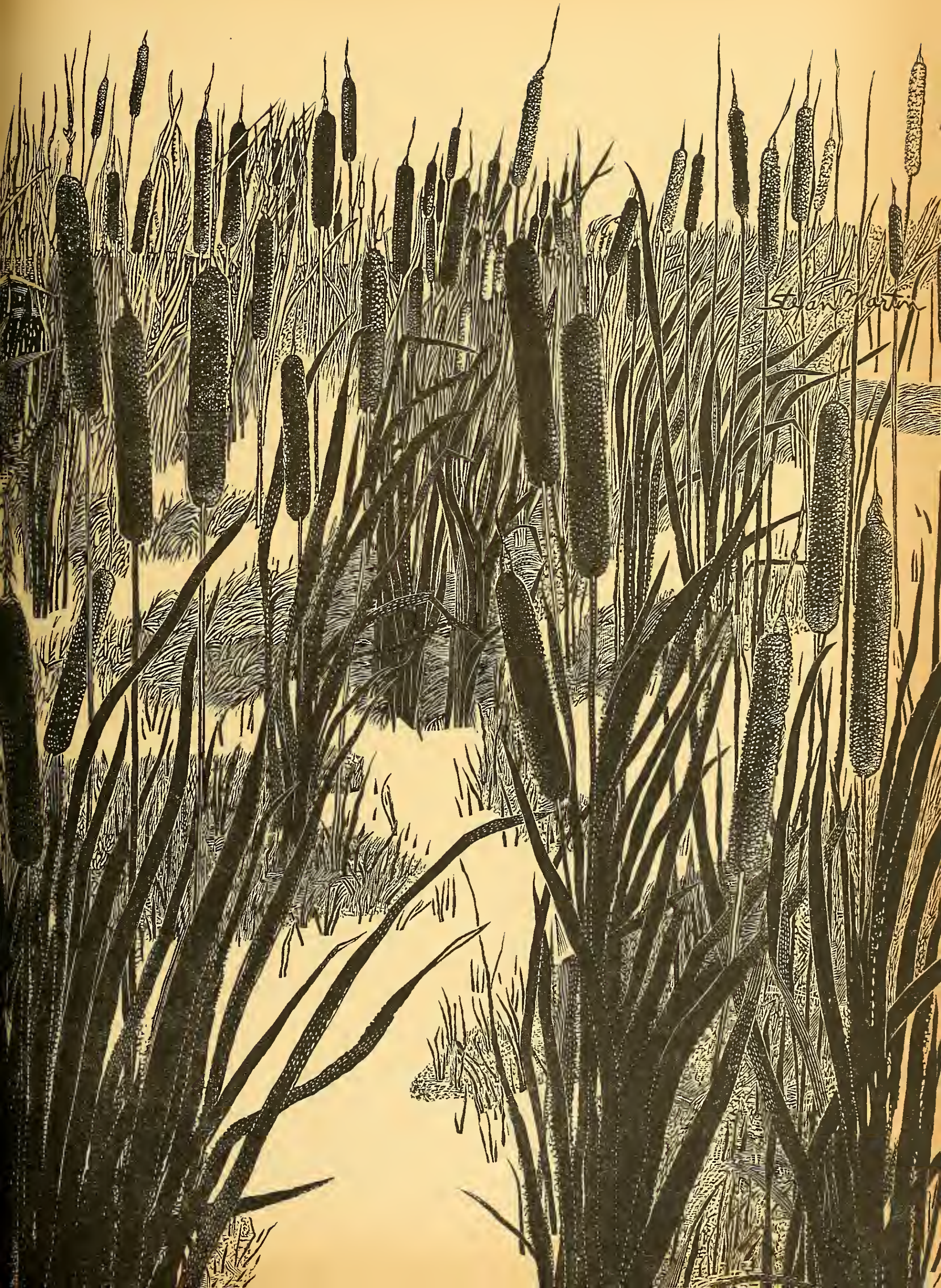
Horn vessel from Northwest Coast carries the distorted figure of prone human with head of an animal.

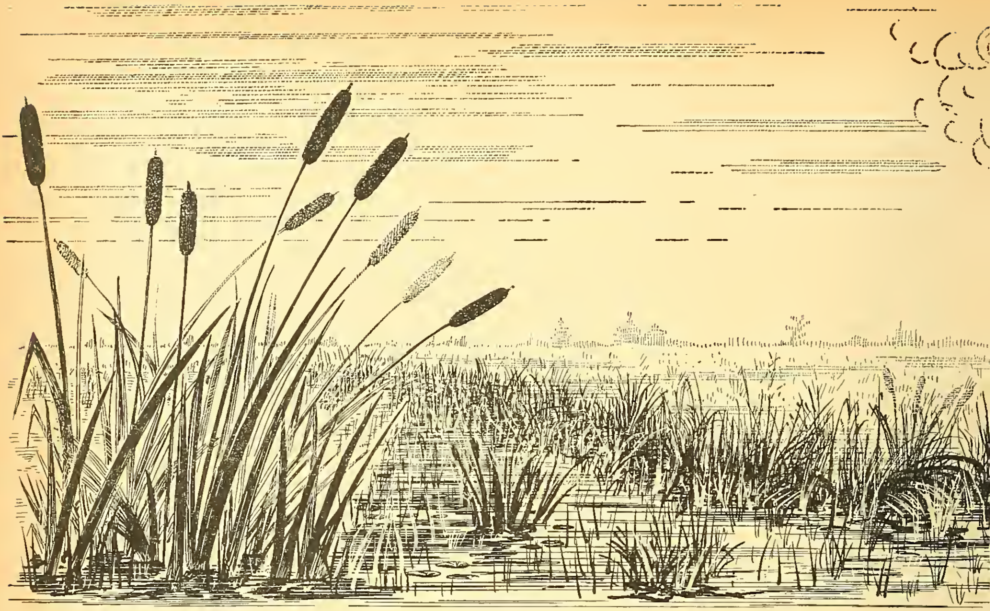




Head of horned animal, modeled in terra cotta, comes from Africa's Guinea Coast. Reproductions are by permission of Jay Leff.

This is the 106th
of NATURE MAGAZINE's
special educational inserts


Stefan Martin



THE MARSH

A Pageant of Natural History

By E. Laurence Palmer

Where land meets water, as in a marsh, the aquatic and the terrestrial patterns of life must be reconciled by those that make such areas their homes. Ecologists—those specialists in the interrelationships between living things and their environments—write about this great compromise in a language that is sometimes difficult for the non-professional to understand. But since it is the ecologists who are most familiar with the basic conflicts of marsh life, let us see if we cannot profit by some of their conclusions.

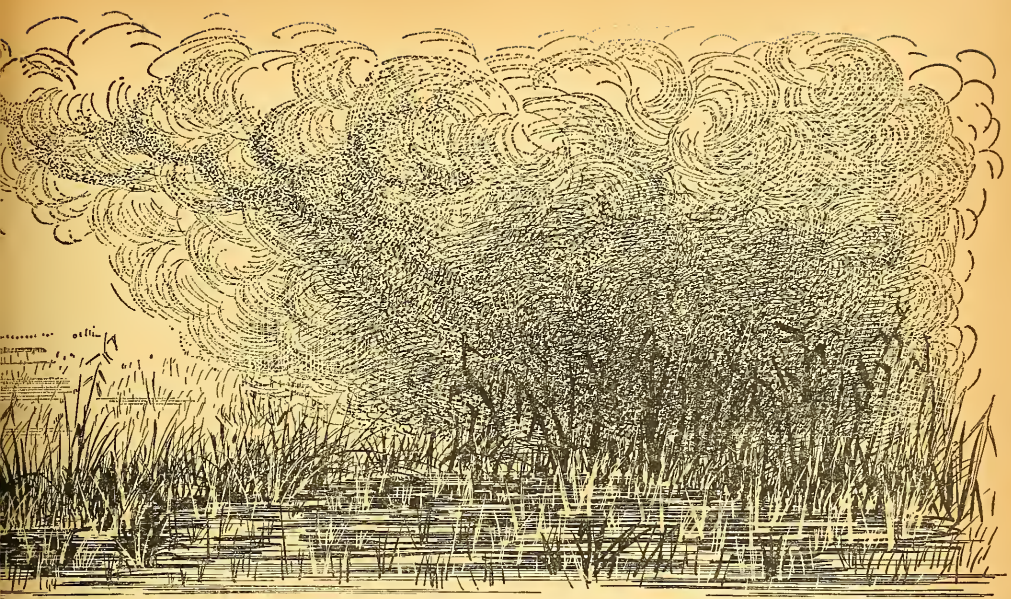
Here, we elect to recognize that, in a marsh, the predominant plant life is herbaceous, while that of a swamp is dominated by the woody plants. We cautiously reject bogs from consideration here, because in bogs there is but little decay of plant material; while in marshes the decay rate is high, with a corresponding abundance of animals that participate in reducing dead tissues to simpler forms—a function that provides material for the development of abundant new living tissue. Much as the gunner finds his best hunting along the borders where woodlands meet grasslands, or where dry lands meet wet lands, we should expect to find such areas good hunting for those whose interest lies in the study of living natural history.

The English poet Shelley made use of a marsh to depict the ultimate in ruin when he wrote: ". . . when
London shall be a habitation of bitterns, when St. F
and Westminster Abbey shall stand shapeless and na
less ruins in the midst of an unpeopled marsh. . . ."
parently Shelley had never been in a boat or a blin
watch a busy marsh day begin or end, for certainly
average marsh is a populous area, zoologically speak

After you have finished reading this article, you
be able to see in a marsh not only beauty, but a g
pageant of natural history displayed in its lands, wat
plants, and animals. You will better appreciate the s
ous human health problems associated with the d
ming of rivers like the Nile, and the serious conserva
problems that may follow the promiscuous drainag
farm marshlands, as in our own Midwest.

A marsh is likely to be a difficult place in which
live, either for plant or animal life. In the hea
summer, humans seek the shade. During a windsto
they seek shelter. From uncontrolled fire they see
safe refuge. During floods they seek dry lands; an
drought, moisture. A marsh can be the playground
all such extreme conditions. How, then, does the lif
the marsh meet high winds, fire, flood, and parc
drought? As an example consider the cattail.

Notice how the cattails of the marsh yield to
winds, instead of resisting and being broken. What h
can the wind do to a plant like the cattail? When
sun is shining brightly, hold your hand, palm downw
in the sunshine. Is the back or the palm of your h
the warmer in this circumstance? Now turn your h
on edge, so that the sun strikes an edge rather tha
flat side. How does this new position affect the am
of heat supplied to your hand? Remember that, in
morning and evening, the sun does not strike the e
as directly as it does at midday. Return, then, to



Late spring fires, sweeping through winter-dried reeds and grasses, bring tragedy to animal life of the marsh.

attail, and consider how this plant is so made that, hrough the lighted part of the day, it gets more heat hen the sun is low, and less when it is high. Thus does ie cattail escape the sun's most withering rays.

IN spring or fall, fires may sometimes sweep the marshlands, particularly the cattail marshes. At such times ie most valuable part of the cattail plant is likely to be uried under an inch or so of water or soggy trash. Can ou imagine a safer place for the precious starch that is tored in this plant? If wind, fire, and burning sunlight annot kill the cattail plant, what about drought? It takes long drought to dry the blanket established by a mass f cattails, and even then there are roots that reach a evel where moisture may still be found. A cattail marsh s a rather stable institution after it has become firmly stablished; and, once established, animal life depends n it for both food and shelter. Muskrats can hide in the wamps, and be certain of ample food under stands of attail leaves that tower over beds of starch-laden underground structures. They are not only protected from iostile neighbors, but from fire as well—they have underground burrows in which to hide until danger has passed.

Perhaps the greatest tragedies for marsh-dwelling aninals occur when late spring fires sweep their habitat. Marsh birds may have begun nesting activities, only to ind that all is lost in a few minutes. There is probably io perfect place for any organism; if there were, that orm of life well might overrun the earth.

Marshes may vary because of the chemical nature of heir waters. There are salt marshes near the sea and iear salt springs, alkali marshes near alkali exposures, and marshes whose waters are nearly pure—or at least elatively free from both salt and alkali. Where animal ife remains in a marsh, we assume that it has adjusted to the chemical conditions prevailing in a given locality.

One of the most interesting phenomena connected with marshes is their tendency to build land. If you have the occasion to handle marsh plants, you may be impressed by the fact that many of them feel "slimy," and seem covered with a gelatinous coating. Such a coating may well be of plant origin, and may be composed of algae. The jelly-like covering tends to collect silt from the water, the silt eventually settling to the bottom to build more land. This may represent a substantial land-building contribution over the years, and may substantially reduce the area of open water in a marsh-surrounded pond or lake.

MORE effective in land building than the algae, perhaps, is the development by many marsh plants of horizontal underwater structures from which the erect parts of the plant arise. Cattails and bulrushes are particularly effective in this respect. They may build structures that resemble floating platforms on both edges of a waterway. Commonly, such platforms are thick enough and strong enough to support the weight of a man, so that in many extensive marshes one can walk all day in water up to the knees and never go deeper, unless an open stream should be encountered.

As far as humans are concerned, land-building may have its drawbacks, especially in the maintenance of open passages for boats. Such land-building accounts, however, for the relatively deep water to be found just off the channels that may penetrate marshes where streams enter them. Eventually, land development in marshes may become sufficiently advanced to allow human agricultural activities.

Dr. E. Laurence Palmer, for many years director of Nature Magazine's educational program, continues his special inserts in the pages of the combined magazines.

The dictionary tells us that a marsh is "a tract of wet or periodically inundated treeless land, usually characterized by grasses, cattails, or other monocotyledons." In our accompanying chart section there are nine representative plants of such an area. Of the two thallophytes, or plants that are not differentiated as to stems, leaves and roots, one is an alga and one is a fungus. A relatively common liverwort, and a moss that may or may not be considered a marsh plant—depending on your definition of the word "marsh"—represent the bryophytes. One pteridophyte, or representative of the fern division of plants, is listed. For the flowering plants, the cattail and the bulrush are suggested as being representative of plants of vertical pattern, while pond weed and cow lily are representative of the plants of horizontal plan. Only one of these four is a dicotyledon; so, in general, we recognize the dictionary's emphasis on the importance of monocotyledons.

While the cattails and bulrushes of a swamp are likely to be conspicuous, there may be other plants present that are of equal importance. The seasonal variation in the abundance of primitive marsh plants is great. At some times of the year, the alga *Nostoc* may become so abundant that it forces its attention on the most casual observer. This alga usually appears as masses of jelly that soon become silt-covered, and which look like semifloating mud balls. Other algae abound, and are conspicuous in their own ways as bright green, slimy threads like *Spirogyra;* delicate nets like *Hydrodictyon;* coarse-branching, somewhat slimy threads as in *Vaucheria;* or as the delicate, branching threads that are characteristic of *Cladophora.*

Many of these plants have been considered in detail in Number 69 of this series, or may be found figured and discussed in biology textbooks. Some of them seem to flourish best in polluted water, and are of some value in superficially indicating the presence of pollution. However, it is not always easy to determine whether the algae are responsible for the pollution, or the pollution responsible for the algae. Anyone who has explored a marsh has probably seen one or more dead fish floating in the water, and almost invariably such fish will seem covered with a fuzz, which is usually the fungus *Saprolegnia*, often known as "water mold."

The bryophytes, which include the liverworts and mosses, are rarely as conspicuous in marshlands as are the other groups. Forms like *Ricciocarpus* may be seen floating, closely crowded, on the water's surface; and the adjacent wet muds may support colonies of *Marchantia,* which may make an almost continuous green carpet close to the soil. The mosses do not ordinarily form a conspicuous portion of the marsh flora, although they may sometimes crowd the tops of floating logs. Sphagnum moss, although included here, is more typically a bog plant.

Among the pteridophytes—the division of plants that includes the ferns and their allies—there are marsh representatives in abundance. Our Number 104 dealt, for
the most part, with this group. To that treatment we
adding the water-clover fern *Marsilea*. The pecu
sporocarps of this plant, which look like fruits but re
are not, are frequently eaten by ducks. These plants p
an important role in anchoring soft soil at the wat
edge, and in helping to build land.

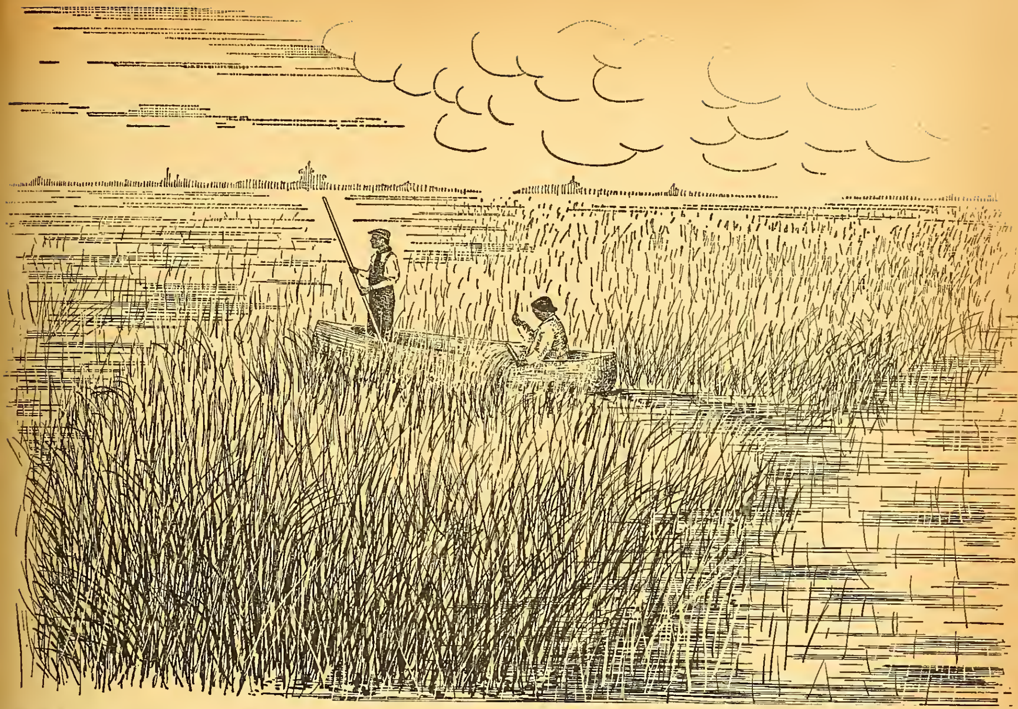
As representatives of the flowering plants, or sp
matophytes, we present the ubiquitous cattail, the l
toric bulrush, and the sometimes conspicuous,
diminutive, duckweed. From time immemorial,
flowering plants of marshes have supplied men with fo
fuel, clothing, and shelter. In some parts of the wo
the major means of transportation may be by boats m
largely of cattails bound together and waterproofed.
many parts of the Old World, home-roofing is still
thatching, secured from the reed *Phragmites*. This sa
reed grows in abundance in many American marshes

Marshes have supplied men with food in the form
wild rice, and flour from cattail tops, collected
season by beating the bent plant-tops, which release th
contents into the bottom of a canoe. The arrowl
group, so common about marsh edges, supplies man w
underground parts known as Indian onion and du
potato. The closely associated bur reed provides a
perior food for muskrats and deer. Sweet flag, which
closely related to the duckweed discussed in the ch
section, has pungent, aromatic rootstocks that are ga
ered, dried, and sold in drugstores, either ground or
their natural condition. It is used as a flavoring for fo
and candy, as a perfume in oils of various sorts, a
sometimes even in soaps.

We must also consider the role of flowering plants
making marshes places of beauty. Some of these plan
like the calla lily and several orchids, are monoco
while others, like the water lily, are dicotyledons. C
American lotus, of the water lily family, is a thing
beauty, and in the South may be sufficiently abund
to provide a food source. Unfortunately, it has b
found that the margins of its leaves provide excell
protection for transforming mosquitoes that may be
ture carriers of malaria. In China and in Egypt the lo
is grown extensively for food, and most of the lotu
produce beautiful flowers, acorn-sized seeds that ta
like chestnuts, and tubers that, when properly prepa
and baked, taste like sweet potatoes.

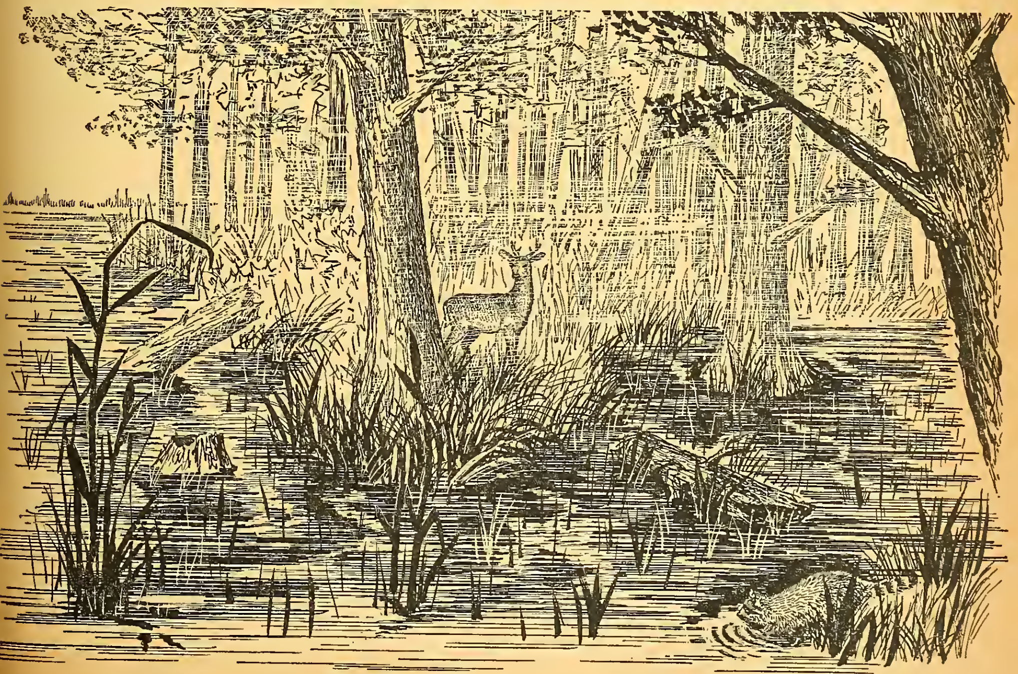
The animals of marshlands are of great importance
our picture of the marsh, and nine are listed in
chart section of this insert, each representing a ma
group. We have included the mallard duck as represe
ative of the birds of such areas, and the muskrat as ty
cal of the mammals; but of even greater interest mi
be representatives of the lower orders, like the proto
ans that swarm unseen. Let us briefly review the r
that marsh animals play in the health, comfort, a
happiness of mankind.

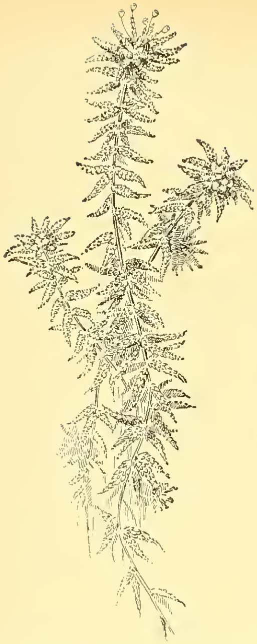
It has long been recognized that there is a relations
between marshes and human health. Explorers ha
found that waterways are convenient highways into u
known territories, and early settlements have often be
near such avenues of travel. However, men early reco
nized that there was an association between such wat
ways and human diseases, like malaria, which is carri



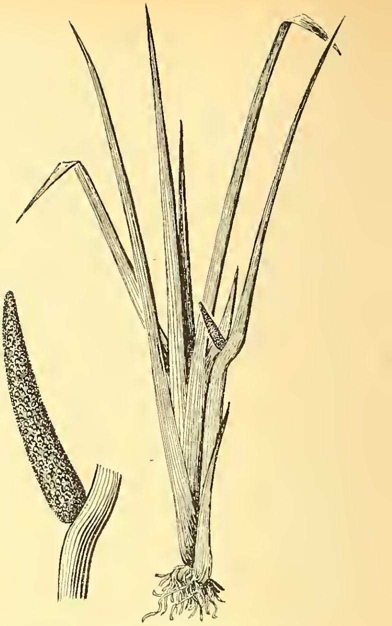
Herbaceous plants, like the wild rice being harvested in the illustration, *above*, distinguish the flora of marshes.

Typical swamp, *below*, is dominated by the woody plants. The soil is saturated, but not wholly covered, with water.

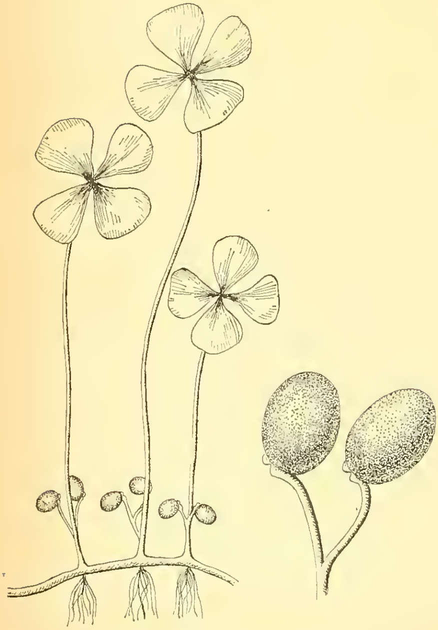




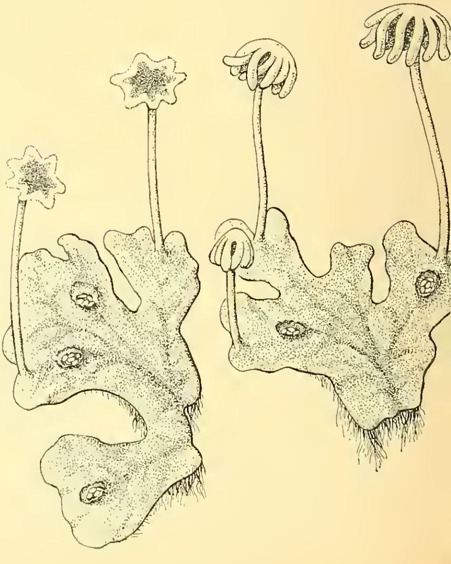
Sphagnum moss, *Sphagnum* sp.



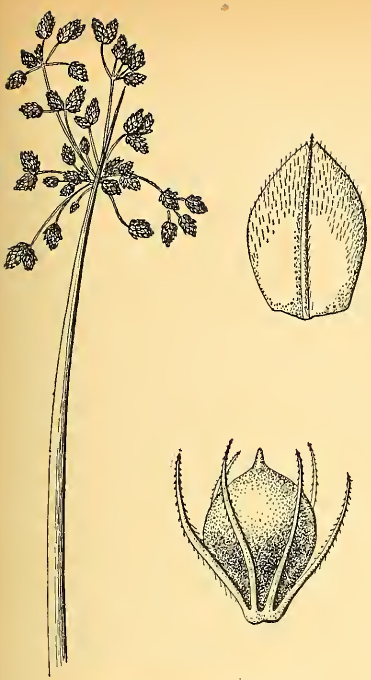
Sweet flag, *Acorus calamus*



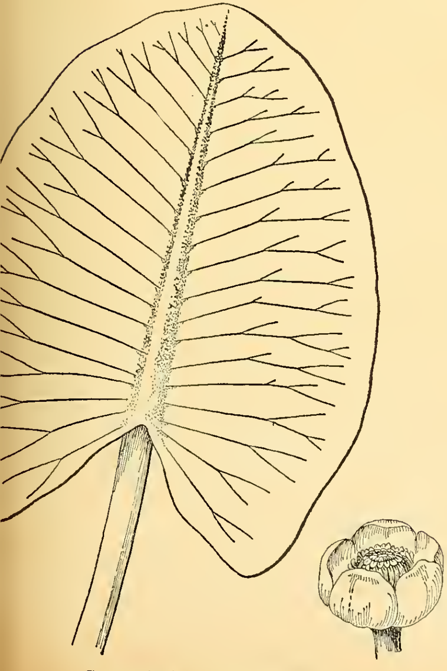
Marsilea, *Marsilea quadrifolia*



A liverwort, *Marchantia polymorpha*



The bulrush, *Scirpus validus*



Spatterdock, *Nuphar advena*

by insects that are part of a cycle depending on marshy conditions. At present, it is particularly important that we have some understanding of this relationship. All over the world we are damming streams to provide power, to irrigate deserts, to increase navigable waters, and to secure water for human consumption. In doing these things, however, we may be creating conditions that we cannot afford to ignore.

If the building of a dam on the Nile River increases marshy areas where human population is high, complications may arise. Such marshes are likely to support pond snails. In turn, the snails may be hosts to organisms that may infect men who wade in such marshes with schistosomiasis, a disease that not only deforms but makes it impossible for an infected person to live a productive life. The building of such dams thus may actually help to increase illness, poverty and misery, although intended, of course, to be of benefit to man.

The shallow waters of marshlands may support mosquitoes and pond snails that can be disease carriers; but they may also support fishes that feed on such snails and insects. We must remember to protect some of these natural controls that are ordinarily present in a marsh.

Marshes are natural breeding grounds for many kinds of amphibians. Even the larvae of the tree toads that live much of their lives in treetops start life in marshy places. Swarms of salamanders invade the marshlands in spring to lay their eggs. A single spotted salamander may lay some two hundred eggs, the young from which may then spend up to three months in the marsh, feeding, in part, on smaller animals that may be undesirable from the human viewpoint. An individual bullfrog, on the other hand, may lay as many as 20,000 eggs, each of which can develop into a polliwog that will feed largely on the oozes and slimes of the marsh.

Marshes provide a favorable environment for many reptiles, too. Some of these, like snapping and painted turtles, spend much of their lives in such areas. They may destroy useful animal life like ducks, frogs, and fishes; but it is not commonly realized that more than fifty per cent of the turtle's food may be waterweeds, and that its appetite for carrion helps speed the destruction of dead animals whose bodies might otherwise be a potential source of danger to human health.

Bird life of the marshes, is, of course, most plentiful; ducks, in particular, provide "sport" and food for many gunners, as well as satisfaction to bird watchers. Few birds of the marshes are undesirable from the human viewpoint, although marsh-inhabiting blackbirds may occasionally be charged with invading man's grain fields in great numbers.

It is doubtful if one could find a marshland that is not the home or range of birds, mammals, reptiles, amphibians, fish, and invertebrates of many kinds. The majority of this animal life is able to survive because of the shelter provided by marsh plants, and practically all of it is dependent on marsh plants as food, either directly or by way of the animals on which the individuals themselves feed. Basic, of course, is the fact that a marsh supplies exactly the right amount of water and soil and sunshine to keep this whole involved society—a pageant of natural history—functioning normally.

	THE SETTING	DESCRIPTION
Pond Scum *Spirogyra* sp.	Warm, shallow, stagnant waters form the habitat of many of the fresh-water algae. Of the blue-green group, both *Oscillatoria* and *Nostoc* thrive in the waters of marshlands. Here we consider the green alga *Spirogyra*, of the Family Zygnemaceae, and Order Zygnematales, Class Phycomycetes.	Other green algae, Class Chlorophyceae, are often abundant in marshes. There are oedogonium, water net, vaucheria, and chara, the latter found in waters high in lime. Pond scum looks like a mass of bright green, slimy strings, sometimes kept afloat by entangled air bubbles.
Water Mold *Saprolegnia* sp.	Water molds are often conspicuous in the polluted waters of marshes, particularly near centers of human population. A dead animal like a fish or cat may support the gray fuzz that generally characterizes this plant. Family Saprolegniaceae, Order Saprolegniales, Class Phycomycetes.	Most water molds are saprophytic, living on dead organic material, but some are parasitic. City folk are likely to see such mold on goldfish in aquariums that have not been kept clean. The plant body resembles a mass of threads without cross-walls or color bodies.
Ricciocarpus *Ricciocarpus natans*	In marshes, conditions may be ideal for liverworts. Some, like *Marchantia*, are best known as earth plants; others, like *Ricciocarpus*, may float on the water. As representative of the liverworts, we name *Ricciocarpus*, Family Ricciaceae, Order Marchantiales, Class Hepaticae.	Common on marsh waters of many lands, including those of the eastern half of the United States. Appear like green triangles, separated or in rosettes, measuring to more than one inch across, with an abundance of thin scales beneath and branched and rebranched grooves above.
Sphagnum Moss *Sphagnum* sp.	Relatively few mosses are to be found in typical marshes. However, sphagnum mosses grow in abundance in and near areas that might be considered marshes, and we elect to consider the moss *Sphagnum*, of the Family Sphagnaceae, the Order Sphagnales, and the Class Musci.	The choice of sphagnum as a marsh plant may be criticized, because the waters of marshes are free to circulate and change with every storm, while those of bogs do not. However, in marshlands, moss specialists are not overwhelmed with an abundance of their chosen study material.
Marsilea, or Pepperwort *Marsilea quadrifolia*	Marshlands support a number of ferns and fern allies. Horsetails, for example, may be abundant in some marshes. Here, however, we consider marsilea, sometimes called "waterclover fern," of the Family Marsileaceae, the Order Filicales, and the Division Pteridophyta.	Marsilea is a native of Europe and Asia that is firmly established in the United States. Most conspicuous are the erect "four-leaf clover" structures that arise from a horizontal body usually buried in the mud. The "clover-leaf" is about an inch across and of a clean green.
Cattail *Typha latifolia*	Strong winds that blow across marshes can do little damage to flexible, ribbonlike leaves of the cattail, and fires that sweep marshes cannot kill parts buried under mud and water. This plant is of the Family Typhaceae, the Order Pandanales, and Class Monocotyledoneae.	Success of the cattail system of survival is attested by the fact that it is found in abundance in temperate climates around the world. Cattails grow to 6 feet high, with leaves to 1 inch wide, which sheath the stem and are filled with large air cells. The horizontal rootstock branches.
Bulrush *Scirpus validus*	Bulrushes meet the conditions of marshlands much as do the cattails, but pioneer farther into the water, sometimes being largely submerged without being destroyed. Bulrush is a sedge rather than a rush. It is of the Family Cyperaceae, Order Graminales, Class Monocotyledoneae.	There are at least 150 species found about the world, some of which grow in water and some on dry ground. *Scirpus validus* ranges from Newfoundland to Alaska, and south to California and Georgia. Stems may grow to more than eight feet high, from stout, horizontal, scaly rootstocks.
Duckweed *Spirodela polyrhiza*	In late summer marsh waters may be covered by floating duckweeds. Related plants include duckmeat, lesser duckweed and watermeal, all floating on water's surface. Duckweed has several rootlets; duckmeat and lesser duckweed, one. Family Lemnaceae, Order Arales, Class Monocotyledoneae.	*Spirodela* is widely distributed in the Old World, and into the tropics in America. The plant is an oval, floating body, bearing two or more rootlets beneath. It is to ⅓ inch long, dark green above and purple beneath. Four to fifteen nerves appear on the upper surface of the frond.
Spatterdock, or Cow Lily *Nuphar advena*	Representing the dicotyledons in this discussion of the marshes is the spatterdock, or yellow water lily. As a rule, the monocots nearly monopolize marshlands. The spatterdock, cow lily, or yellow water lily is of the Family Nymphaceae, Order Ranunculales, Class Dicotyledoneae.	Found in waters and marshes and along slow streams from Labrador west to the Rocky Mountains, and south to Florida, Texas and Utah. Members of family widely distributed. Leaves are to 12-inch blades on petioles that may be more than a foot long. Rootstock may be 4 inches through.

FOOD	REPRODUCTION	GENERAL IMPORTANCE
Spirogyra manufactures its own food by using light, water and carbon dioxide, the water and carbon dioxide entering into the composition of the ultimate products—sugars and starches. Oxygen is freed, and the entangled bubbles found in masses of *Spirogyra* may actually be free oxygen.	*Spirogyra* increases by growth and division of strings of cells and the cells themselves. There may also be a sexual reproduction in which contents of cells in parallel strings join to make single cells. This may be induced by a change of ratio between the volume of water and its surface area.	*Spirogyra* may be a serious pollutant of fresh water in marshes, although it may produce a basic food for some marsh animals. Algae may clog drains controlling marshlands, and may restrict the movements of fishes and other animals living in marshland waters.
Water mold gets its food wholly from other plants and from animals, the threads penetrating the tissues of the host and extracting the needed nourishment. Some members of the genus are serious menaces to crops, often attacking the growing roots and finally destroying the plant.	Reproduction in water mold is by division of the plant body. Also, the ends of some threads may produce hosts of microscopic swimming spores that become freed, swim about, and develop new threads on suitable sites. A sexual method of reproduction also is known.	*Saprolegnia* is both a blessing and a curse. It serves to destroy wastes that might otherwise persist. It also serves, unfortunately, as a menace, particularly in fish hatcheries and in some crops. In aquariums it may be controlled by addition of salt to water.
Compact floating mats may cut off light under water to limit the growth of certain plants there. May serve as food for ducks and other plant-eating animals of the environment. Are to be found almost wholly in the warmer summer seasons, vanishing with the onset of cooler weather.	Reproduction is by growth and division of the rosettes of triangles. The floating form reproduces by means of spore-bearing capsules in April, the spores of which develop into plants that are sexual. The spore-case stage of *Ricciocarpus* is, however, asexual.	This species is sometimes known as the purple-fringed riccia, because of the abundant scales underneath. It has been described as looking like duckweed, but this is far-fetched. It is likely to be confused only with those plants that are most closely related to it.
Mosses do not ordinarily enter into the diets of many animals, and their prosperity is dictated more by chemistry than by systematic zoology, since the associated animals use the moss more as a cover than as food. It may be interesting to note the sparsity of mosses in the marsh environment.	Mosses, including the sphagnum mosses, are usually most conspicuous in the sexual, or gametophyte, stage. In many mosses, this stage is characterized by stemmed structures supporting spore capsules. In the sphagnum mosses, the supporting stems are either conspicuously short or absent altogether.	Sphagnum mosses are valuable as retainers of water, and are widely used to pack commercial shipments of plants. The peat of commerce, used as a fuel in many parts of the world, is derived from dead sphagnums that, although compacted, have not reached the stage of complete decay.
Plant parts of marsilea are eaten by ducks, and to some extent by fishes. The plants are relatively free from injury by insects and fungi. The fruiting bodies are hard and dry, and serve to tide the plants over times of unfavorable conditions. These fruiting bodies, or sporocarps, are remarkably hardy.	Reproduction is primarily by division of the vegetative parts, particularly those buried in mud. The sporocarps are parts of the sporophyte, and may produce large or small spores. The larger develop into the female, and the smaller into the male stages, which then unite to form the plant.	Water-clover fern may serve as a valuable anchor in holding soft muds intact against the action of currents, waves, and the actions of animals. It provides good shelter for a number of marshland animals—muskrats, for example—and helps build up marsh bottom.
Cattails have few natural enemies abundant enough to do serious damage, in spite of their storage of rich, starchy food underground. Waterfowl lack the strength to harvest cattail wealth, and soft mud bogs down such animals as might adjust to grazing on cattail roots.	Cattails reproduce by their spreading, horizontal underwater rootstocks, which are perennial and persist in holding territory once occupied. They also bear spikes, the lower portion yielding fruits, and the upper portion stamens that produce the necessary pollen.	Leaves are used by man in making rush-bottom furniture, in calking barrel staves, in manufacture of insulating material. Fluffy fruits are used in pillows and blankets. Starchy rootstocks are a good emergency survival food; young fruiting stalks are sometimes eaten as "Cossack asparagus."
Bulrushes provide food and shelter for many forms of wildlife, both bird and mammal. Muskrats and ducks are often largely dependent on these plants for survival. Most land mammals cannot pursue them in marshy areas, and a patch of bulrushes provides a superior hiding place for lesser life.	Major reproduction is by persistent branching of horizontal rootstocks. Also, nutlets are borne in the branching, fruiting portions of plant. These nutlets may be egg-shaped, black, to nearly .1-inch long, somewhat flattened on one side, are hardy, and are often found in considerable abundance.	Bulrushes provided concealment for the infant Moses, according to the Bible. They are superior builders of land, while the fleshy rootstocks are eaten raw, bruised, boiled, or made into flour. The young shoots or stem bases may provide man with a source of food during an emergency.
Duckweed may affect the ecology of underwater areas by cutting off light, but may also serve to keep water temperatures down. Ducks swim through masses of the plants, gorging themselves, while muskrats may also feed on this plant of the marshland.	Reproduction is largely by division and growth of the floating plant body. It is seldom found in flower. Ovary borne under plant yields two seeds in a round, wing-margined fruit, which is not likely to be found. Anthers of stamens are two-celled, but are also hard to find.	Duckweeds may be found in places similar to those occupied by *Riccia* and its relatives. Duckweeds, however, fill a definite role in the economy of the water surface between the stems of marsh plants in the late summer season. The name properly associates chief food function.
Deer, moose, beaver and porcupines feed on raw, sweet rootstocks. Ducks eat seeds, and men roast them for food. The yellow flowers are commonly crowded with insects and the leaves may show insect injury; but in spite of such predation, the plants may appear to be quite thrifty.	Flowers are to 3½" in diameter, like flattened globes, with six sepals. Petals are fleshy, and less than ½" long. Flowers appear yellow, with a purplish cast outside. Fruit is to 2" long and 1" thick, with many seeds inside. Stamens are numerous, as in the water lily, and are in five to seven rows.	Some western Indians have used the seeds to make a flour for bread. If the seeds are to be stored, they must not be allowed to dry, or viability is lost. The stout rootstocks are ideal for anchoring a shoreline along stream or marsh, where wind or wave action causes severe erosion.

	THE SETTING	DESCRIPTION
LEECH *Placobdella parasitica*	Turtles found in marshes are commonly hosts to leeches that attach themselves to the soft under parts of the animals as parasites. From among the invertebrate animals of marshes, we choose this leech of the Family Glossiphoniidae, Order Rhynchobdellae, Class Hirudinea.	This leech is free-living during the breeding season, but is otherwise found clinging most commonly to the legs of snapping turtles. This is the largest species in the genus, to over 2″ long, dark greenish-brown, variously spotted and striped with yellow and orange.
DISC POND SNAIL *Helisoma trivolvis*	Marshlands are both a blessing and a curse, and mollusks contribute to making them so. Involved are both univalves, like snails, and bivalves, like clams and mussels. Of the univalves, the disc pond snail is of the Family Planorbidae, the Order Pulmonata, and Class Gastropoda.	Pond snails, for the most part, live in waters from 1 inch to 6 feet deep, and have shells to nearly 3 inches long. They are most abundant in waters having a *p*H above 7.0, and more species are to be found in large bodies of water than in small. The shell of this snail is a flat coil.
CRAYFISH *Cambarus bartoni*	Marshes rich in decaying plant material and with soft bottoms provide homes for many crustaceans. Freshwater shrimps and water sowbugs revel in abundant food, and serve as food for others. Abundant also may be the crayfish, of Family Astacidae, Order Decapoda, Class Crustacea.	Of some 70 species of *Cambarus*, *C. bartoni* is from streams east of the Mississippi. *Cambarus* has 17 pairs of gills, while Pacific Slope genus, *Astacus*, has 18 pairs. There are about 100 species in all. Length is up to 5 inches, with 2 large front claws and 4 pairs of walking legs.
MOSQUITO *Culex pipiens*	Man's establishments near marshes have sometimes failed because of insect populations. Abundant are mayflies, dragonflies, water bugs, water beetles, caddis flies, and many others; but representative is the mosquito, of the Family Culicidae, the Order Diptera, and Class Insecta.	*Culex pipiens*, the house mosquito, is common wherever there is stagnant fresh water, but it is most abundant in marshes. Female is to 1/6″ long, proboscis slender, brown, dark-tipped. Abdomen is black, with bluish to bronze reflection. The hind legs, at rest, are held upwards.
CARP *Cyprinus carpio*	Warm, shallow, fresh waters lying over oozes with abundant decaying plant material and aquatic invertebrates are "heaven" for many fishes. Minnows are important here, including the immigrant large carp, of the Family Cyprinidae, Order Cypriniformes, and Class Teleostomi.	World-wide, carp are among the commonest fishes invading the waters of marshlands for living and breeding. Native to Asia and Europe, they are widely established in American waters. They are coarse-scaled or scaleless, dark brown to yellow or golden, with 4 barbels near mouth.
VERMILLION-SPOTTED NEWT *Diemictylus viridescens*	Marshes are the habitat of many amphibians, including frogs, toads, and salamanders, particularly during breeding seasons. The bullfrogs and green frogs may pass entire lives there. Representative is vermillion-spotted newt, Family Salamandridae, Order Caudata, and Class Amphibia.	Eastern newts, *Diemictylus* sp., and Pacific newts, *Taricha* sp., populate marshy areas from coast to coast. *D. viridescens* may be to 4″ long. Adult is brown and black, with yellow beneath, black and red spots, finned tail. Land form, immature, is mostly pale red, lacks tail fin.
SNAPPING TURTLE *Chelydra serpentina*	Shallow waters, deep muds, and abundant animal life provide ideal habitat for turtles such as the soft-shelled, musk, mud, spotted, painted, and diamond-backed. Highly representative among these is the snapping turtle, Family Chelydridae, Order Testudinata, Class Reptilia.	Snapping turtles range eastern North America, east of Rockies, from southern Canada south. Length, to more than 3 feet. Upper shell, 1 foot; lower, to 8″ long. Under parts poorly protected. Weight up to 86 pounds, while that of related alligator snapper to more than 200 pounds.
MALLARD DUCK *Anas platyrhynchos*	Many marshes are created by man to supply breeding grounds for valuable bird species. Representative birds include ducks, some geese, rails, coots, and many others. Among most representative of marsh birds is the mallard, Family Anatidae, Order Anseriformes, and Class Aves.	Mallards and close relatives are probably commonest of all ducks, being found nearly world-wide where habitat exists. Length to 28″, including a 4½″ tail. Wingspread to 40″. Drakes commonly with green heads and white collar, with a purple breast and gray under parts. Flesh superior as food.
MUSKRAT *Ondatra zibethicus*	By draining, flooding, and cultivating, man makes or destroys more marshland than any other mammal. Representative mammals are beavers, mink, otters, nutria, rats, and mice. Also typical may be the muskrat, of the Family Cricetidae, Order Rodentia, Class Mammalia.	Muskrats range most of North America north of Mexico. Adults weigh to 3 pounds, are 25″ long, with 10″ scaly tail. Except for tail, has heavy, fine pelt. Fur is sold as Hudson seal, Russian otter, red seal. Flesh is excellent and often is included in dishes in which chicken or terrapin forms the basis.

FOOD	REPRODUCTION	GENERAL IMPORTANCE
Leeches feed primarily by sucking the blood of the host after piercing the skin. They are primarily external parasites, unlike the flukes, hairworms, and hookworms of closely related classes and order, all of which may be found in the marsh type of habitat in some development stage.	Individuals bear both sex organs, but two individuals reciprocate in the breeding act. No egg cocoon is formed in this species, the young remaining attached to the parent animal. Are easily carried over wide territories, attached to feet of ducks or in water as parasites attached to fishes.	Important members of the Phylum Protozoa are to be found in fresh-water marshes. On these two pages, we have chosen one representative each of the Mollusca, Arthropoda, and Insecta; and one fish, one amphibian, one reptile, one bird, and one mammal as typical of marsh life.
Pond snails feed largely on oozes and plant wastes of waterways, using a rasp in the mouth to prepare food. They are eaten freely by fish and other aquatic animals. Schistosomiasis, a disease of man, is caused by a parasite of a pond snail closely related to and resembling *Helisoma trivolvis.*	Both sexes are represented in an individual disc pond snail, with mating reciprocal between two individuals. Eggs, laid in small jelly masses, hatch in from two to three weeks into snails whose shells are at first left-handed, with opening to left when spire is pointing upward.	On a world-wide basis, probably the most important role of pond snails is in connection with parasites that affect domestic animals and man. Schistosomiasis, involving pond snails, may debilitate whole populations and make them ineffective, especially where men free wastes in water.
General scavengers, feeding on both plant and animal matter, living or dead. Some live in turret-topped burrows, others among stones or in debris. With growth may shed outer shell and expand during the "soft-shell" period. The crayfish is able to regenerate lost limbs. Is prey for fish, mammals.	About 2 years from egg to egg. May breed through the year. Female carries to 200 eggs under her body for about 2 months, eggs hatching 2½ months after mating. Larvae may be free of mother after 3 months. May be reared in captivity, largely for use of fishermen as bait.	Management for profit consists primarily in controlling water supply, keeping enemies away from the animals, and providing needed food supplies. May be pests in hatcheries, or where fish eggs are available. Valuable as laboratory animals. Some 330 tons are harvested annually.
Male house mosquitoes feed largely on plant juices, and do not bite animals. Females feed on the blood of animals, including man, and are active day or night, feeding mostly in dim light of morning or evening. Greatest enemies probably are drought and the poison sprays of man's civilization.	Sexes may be brought together in part by sounds produced by female. Eggs are laid in rafts of 100-300, which hatch in 1-5 days. Larval period lasts from 1 to 2 weeks, and pupal stage a few days, during which time the pupa may be easily killed by an oil film on water of habitat.	Mosquitoes and their larvae may serve as food for fishes, or for other insects. Control is by draining of breeding sites, spraying of areas involved with oils and poisons, screening of houses and spraying of their interiors, or, in an emergency, by the ancient but effective method of swatting.
Carp feed on decaying organic matter or on plants or small animals found in mud. They are largely scavengers, but also destroy fish nests and young. Their reproductive capacity makes it difficult to control their numbers, and they pre-empt territory more valuable for other species of fishes.	Eggs are laid in early summer in shallow waters with no nest, no parental care. Eggs may number two million per female, hatch in 5-13 days, and young may reach maturity at 2-3 years. Have been known to live over 47 years. Can survive salinity up to 10 per cent for a short time.	Ordinarily a most unwelcome fish, but one that is now considered of some sporting value if taken on light tackle. Food value of the flesh is low, but may be of value in a crisis, since the fish are usually easily taken on a hook and line with nothing more elaborate than plain bread dough as a bait.
Newts on land feed almost wholly on small invertebrates. Adults in water may feed on eggs of fish and frogs, on mosquito larvae, tadpoles of frogs, toads, and salamanders. In destroying many aquatic insects, like mosquitoes, salamanders may prove themselves highly useful to mankind.	Adults mate in shallow water in spring. Fertilized eggs deposited separately on submerged water plants, a single female laying to more than a hundred eggs. Eggs hatch in 20-35 days into gilled larvae, which may live in water to 3 months, absorb gills, and then take to land for from 1 to 3 years.	Serve as food for fish and other animals of the habitat, but more importantly as enemies of eggs and young of other animals their size. May be particularly destructive in hatcheries. The land form is known as the "red eft," seen commonly on woodland paths after a summer rain.
Snappers feed mostly on animal matter like fish, ducks, and carrion. Are essentially scavengers. Pond may support two snappers per acre. May wander over a wide territory. Chief enemies of snapping turtle are man and the elements, although skunks may also destroy many turtle eggs.	Males may fight for mate. Breeds April-November. Eggs laid May-October, in two or more clutches of to 80 eggs that are white, parchment-covered, 1¼" spheres. Nest ashore in dry earth or sand, usually within 75 feet of water. Young hatch in 81 or more days, take to water promptly.	Dangerous predator of habitat, particularly to raisers of ducks, fish, frogs, and other marsh animals. May concentrate in numbers during hibernation. With floats attached to shells, have been used to locate drowned persons. Commercially captured in wire-cage baited traps.
Feed mostly on plant material, including grain and vegetation, but also destroy great numbers of mosquito larvae. Domestic mallard is of same species as wild mallard. Enemies include fire, epidemic diseases, starvation, and over-hunting, as well as natural animal predation.	Nest is usually built near water, commonly on ground, fairly well hidden. Eggs, gray-green to brown, 6 to 13, with nest sometimes shared by two females. Incubation 26-28 days, by female only. Duckling downy, yellow, and able to swim soon after hatching. May be domesticated easily.	Most valuable game bird, but becomes domesticated too easily to satisfy average gunner, who might as well go hunting in poultry yard. Abundance of mallards and ease of harvest helps sell hunting licenses, thus building up financial resources of state conservation departments.
Muskrats feed largely on plants. Using wastes, they build mounds that, when frozen, provide protection from enemies like wolves, dogs, coyotes. Enemies also include mink, some snakes, hawks, owls, human trappers. Fires may be calamitous. Active day or night, winter or summer.	Muskrats are polygamous, and may bear 4-11 young, 19-42 days after mating, and may have to 3 litters a year. Can safely remain submerged to 12 minutes. Good marsh management, including intelligent harvest, may have a beneficial effect on a muskrat population. Do not flourish in captivity.	Muskrats have been considered as the most valuable fur resource in the country. They are generally harvested by the most inhumane of means, but their role in human economy may be taken over by the nutria or by synthetic furs. Can cause damage to earthen dams, some farm crops.

nature IN THE SCHOOL

It is harder, sometimes, to keep youngsters out of marshes than it is to keep them in schoolrooms. This is an observation that applies with as much force to youngsters who are just beginning their school lives as it does to those about to finish high school. But it must be admitted that marshes are most interesting places, particularly at the time of year when school is about to close. At that time, a marsh is fascinating in what may be heard, seen, smelled, tasted and felt.

Now, the frog choruses are at their height. The peeper orchestra, which commenced almost as soon as the water was free of ice, has begun to wane, it is true. Wood frogs may also have become quiet, but the tree toads will likely continue on into summer—although not in chorus proportions. A few bullfrogs, and certainly a number of green frogs, will add to the sounds that may be heard in the marsh.

At this time of year the school might make a study of the frog sounds that are to be heard in some nearby marsh. At least two valuable recordings of frog and toad sounds have been made in this country, recordings that will be found most useful in identifying the various sounds. A class may decide it would like to locate such animals, using the available professional recordings; or it might decide to make its own recordings of marsh sounds with a portable sound recorder.

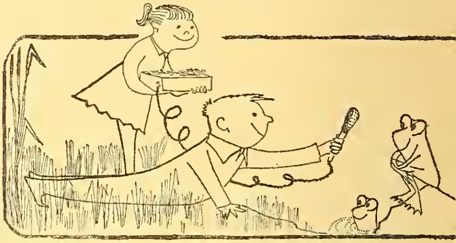
Other youngsters might be interested in collecting the egg masses left in the marshes by various species of frogs and toads. Should this be done, it is important that "wholesale" collections of such egg masses be discouraged as leading to unnecessary destruction of future highly useful animals. An explanation of the reason for this tempering of enthusiasm may be effective as a general lesson in conservation.

If a few egg masses of frogs, toads, or salamanders are brought into the classroom and kept in an aquarium, youngsters may derive from them a notion of events that take place in a marsh. One such egg cluster might be broken up, and a few of the eggs placed in an aquarium whose sides and bottom have been thoroughly cleaned, and in which the sticks and stones have been cleaned of all their oozes.

After a few days it may be observed that the polliwogs in a clean aquarium are not so prosperous as those in an ooze-supplied aquarium. From this fact the youngsters may draw some conclusion as to the role played by oozes and slimes in the general economy of the marsh. Many tadpoles, in their earliest stages, will remain suspended on the sides of the aquarium, rather than resting on the bottom or among the water plants, and such individuals may be observed feeding on the ooze of the aquarium wall.

Two aquariums of approximately the same size may be stocked with clusters of frog or toad eggs so that nearly equal numbers of tadpoles will develop in each. For the purpose, two-quart fruit jars may equally well be used. If an adult newt or other aquatic salamander that is normally an inhabitant of the marsh be added to one of the jars, it will be observed how nature takes care of surplus populations. The salamander may someti
be seen resting on a mass of frog eggs, waiting for
tadpoles—and a salamander's meal—to emerge. S
pupil might like to find out whether the salamand
reaction would be the same for its own eggs. Such
observation may suggest to the students how nat
control is accomplished, and also the reason why i
necessary for frogs and toads to lay so many eggs
the egg-laying habits of the newt are observed, it
be found that these animals lay their eggs singly, as
the peepers that lay their eggs early in the season.

It is not likely that school will be in session w
the bullfrogs and green frogs lay their great sheet
floating egg masses. The tadpoles of these frogs
require two full summers of development in the n
before they can transform into the adult frog fo
Under such circumstances, it may be obvious why
order that a species may survive, such frogs must
as many as 20,000 eggs, as compared with the hunc
or so laid by frogs whose larval development-tim
shorter. Frogs, either as tadpoles or adults, are relis
by many of the inhabitants of the marsh. Through
servation and reading, a class should note the affinit
fish, reptiles, birds, and mammals for a good mea
"frog," no matter what the stage of development of
unfortunate amphibians may be!



The class lesson in frog study might lead to a be
understanding of conservation problems if it
lowed the life history of the frog or the toad beyond
scope of aquarium study. For example, frogs may
grate, and if a student should be riding in an automo
on a rainy night, he might see these animals migra
in great numbers. He might notice that barriers
railroad or highway embankments may sometimes in
fere with such frog migrations.

In the past, great numbers of frogs were capture
simply directing them, during migration, into con
ient enclosures by means of barriers. So successful
this practice that it became necessary for a numbe
states to make it illegal.

For our marsh-life example in this article we
used the well-known frog; but we might well have
almost any of the other marsh dwellers. Further expl
tion of the marsh is sure to reveal a rich variety
animal life, a better understanding of which will be
rewarding to the young naturalist.

we have plumbed the depths

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The Wonderful World OF THE SEA
THE ILLUSTRATED BOOK OF THE SEA
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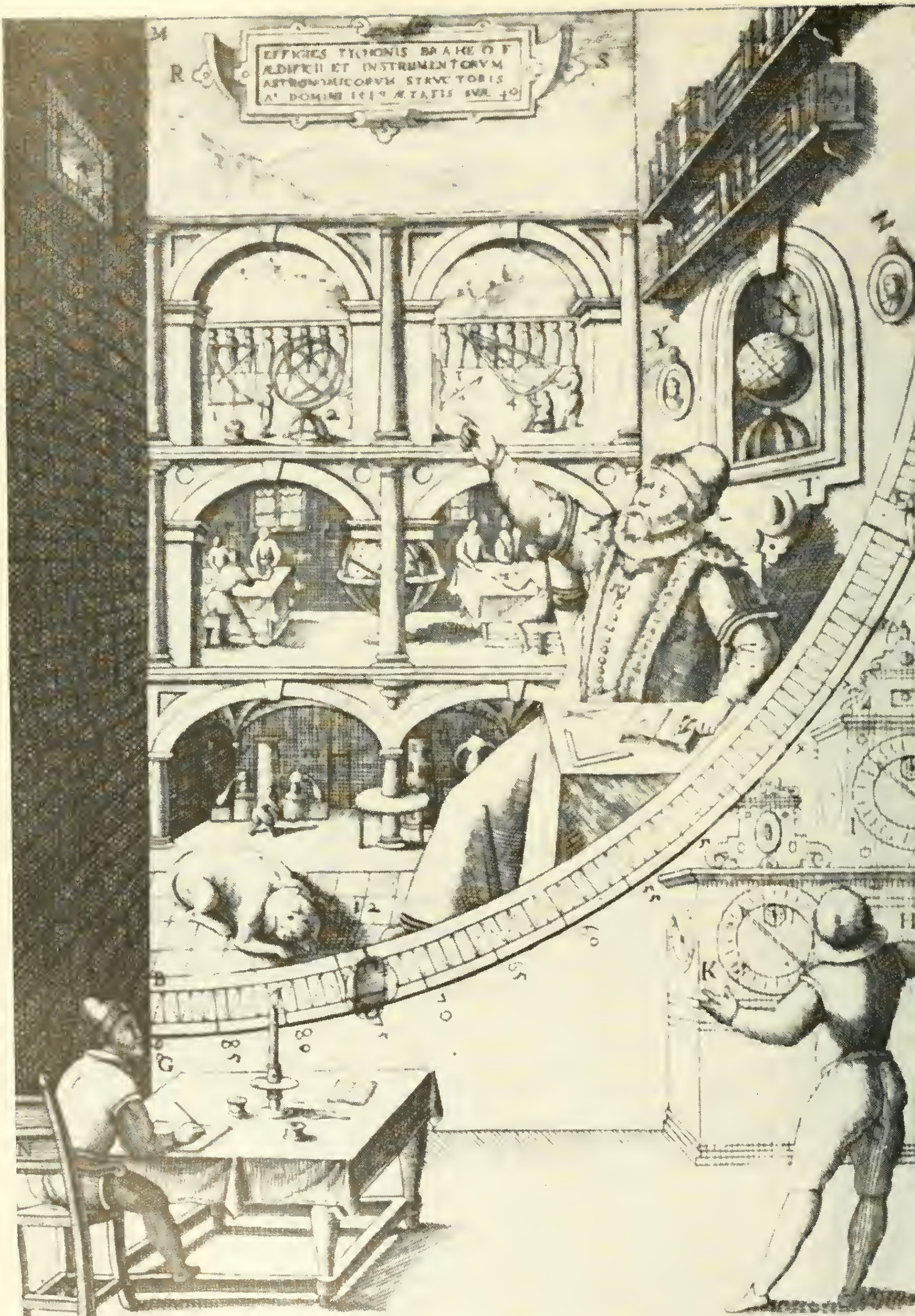
EFFIGIES TYCHONIS BRAHE O F
ÆDIFICII ET INSTRUMENTORVM
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SKY REPORTER

Astronomer of the Sixteenth Century

By Simone Daro Gossner

HE DANISH ASTRONOMER Tycho
Brahe was born in Scania (now
art of Sweden) on December 14,
6. His early studies did not in any
prepare him for a scientific ca-
r. The uncle who supervised his
cation wanted him to study law
frowned on his budding interest
stronomy. As may be expected in
outh of that age (Brahe was sixteen
hat time), such constraint gave the
ly of constellations and celestial
ies all the attraction of forbidden
t. Without formal instruction, he
ght himself the essentials of mathe-
ics and astronomy. As soon as cir-
stances allowed it, he acquired
e instruments, and eventually gave
is other studies to devote all of his
e to his scientific pursuits.

uropean scholars of that epoch
e accustomed to travel extensively
he great centers of learning. After
ral trips to Germany and parts of
, in the course of which he per-
ed his observing techniques, Brahe
d himself won over by the pleas-
living and academic atmosphere
he city of Basel. He was preparing
ettle there permanently when an
xpected event brought about the
test turning point in his career.
g Frederick II of Denmark, aware
rahe's growing reputation, offered
the island of Hveen as the site for
bservatory, with the promise of
tantial remuneration. In 1576,
he began the construction of
niborg Castle (for Urania, muse
stronomy) and of the greatest ob-
atory of his time.

veen is a diminutive island, about
miles wide, located in the Sound
h separates Copenhagen from the
dish mainland. Brahe designed
niborg to serve as residence for
self and his assistants, and as hous-
for his instruments. The castle was
ounded by a walled garden. A
t distance away, outside the walled
osure, Brahe established a second observatory, named Stjerneborg (from *stjerne*, the Danish for "star").

Stjerneborg was a most peculiar structure. The entire building was underground, with only its cupolas showing. The purpose behind this was to provide a firm foundation for the instruments and to protect them from the elements. Brahe, however, had another, and more subtle, reason for Stjerneborg. He wanted to segregate his assistants, that they might not compare the results of their observations before he could inspect them himself.

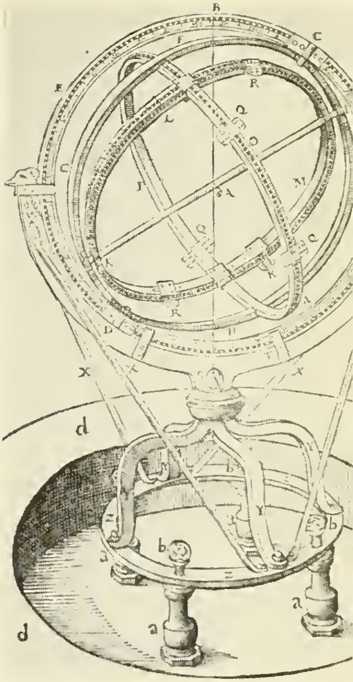
TELESCOPES were still unknown when Uraniborg was built. Except for the brass globe (bottom picture at right), which merely helped in locating the naked-eye stars, Brahe's instruments were all intended for the accurate measurement of angular distances between celestial bodies. Designed by Brahe and built under his supervision, they were the finest in existence. With his great mural quadrant (see opposite page), Brahe boasted that he could measure angles to within five seconds of arc.

Paradoxically, it was the accuracy of his observations that made him reject the theories of Copernicus. The latter's calculations had been based on earlier and less reliable data, and his predictions of planetary positions were bound to reflect these inaccuracies. Brahe, in turn, could not fail to notice them—but drew the wrong conclusions.

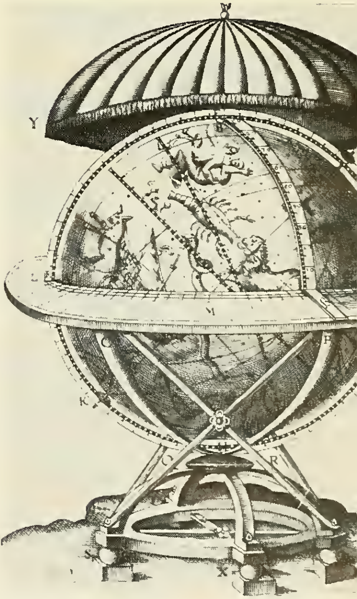
On the other hand, Brahe's careful records of accurate positions for the planets furnished the material on which his disciple Johannes Kepler based his theory of planetary motions and thus laid the foundation of modern celestial mechanics.

The tide of Brahe's fortune turned abruptly in 1597. The new king, Christian IV, who did not share his father's regard for astronomy, withdrew the royal subsidy. Embittered and heartbroken, the aging Brahe left the island of Hveen to seek another patron in a foreign land. Fifty years later, there was nothing left of Uraniborg but a mass of ruins, and the island of Hveen had been completely deserted.

AL QUADRANT, to measure altitude
tars, dominates Brahe's portrait,
This was his largest instrument.



Zodiacal Armillary was an invention of Classical times — to find position of stars — that Brahe later perfected.



Brahe's globe, five feet in diameter, showed a thousand of the stars seen by sixteenth century naked-eye observers.

THE SKY IN APRIL

From the Almanac:

First Quarter:	April 4, 2:05 A.M., EST
Full Moon:	April 11. 3:28 P.M., EST
Last Quarter:	April 18. 7:57 A.M., EST
New Moon:	April 25, 4:45 P.M., EST

For the visual observer:

For the most part of their diurnal course, all planets will still be in the morning sky in the month of April.

Mercury will rise in the east, about an hour before sunrise on April 1, forty-five minutes before sunrise on April 15, and half an hour before then on April 30. On April 7, Mercury will reach its greatest western elongation and the alert observer may catch a glimpse of it, low on the southeastern horizon, between dawn and sunrise.

Venus (magnitude —3.3) will be close to the sun, rising approximately half an hour before sunrise during most of April. Observers who have an unobstructed view of the eastern horizon may see it very low in the east after dawn.

Mars (magnitude +1.2), in Aquarius, will rise about ninety minutes before the sun on April 1, and one and three-quarters hours before it on April 30: the planet will be found low in the southeast shortly before sunrise.

Jupiter (magnitude —1.9) will rise in the southeast at about 1 A.M., local standard time, on April 1; at midnight on April 15; and at 11 P.M. on April 30. It will be located in Sagittarius, low in the southern sky at dawn.

Saturn (magnitude +0.7) will be also in Sagittarius, about fifteen degrees east of Jupiter. It will rise in the southeast at approximately 2 A.M., local standard time, on April 1; at 1 A.M. on April 15; and at midnight on April 30. It will be found in the southern sky by sunrise.

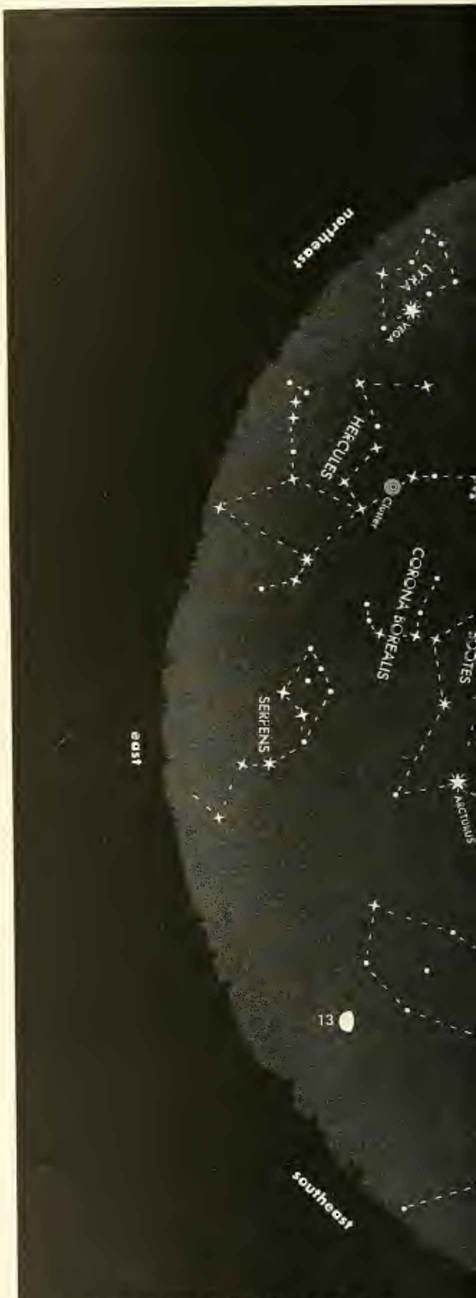
Meteors:

The Lyrid meteor shower (April 21-23) is expected to reach its maximum on the night of April 22. The radiant of the shower—that is, the point from which the meteors appear to diverge—is located near Vega in the constellation Lyra (see sky map, *right*). In fact, shower meteors enter the earth's atmosphere in essentially parallel paths. The effect of divergence is only one of perspective.

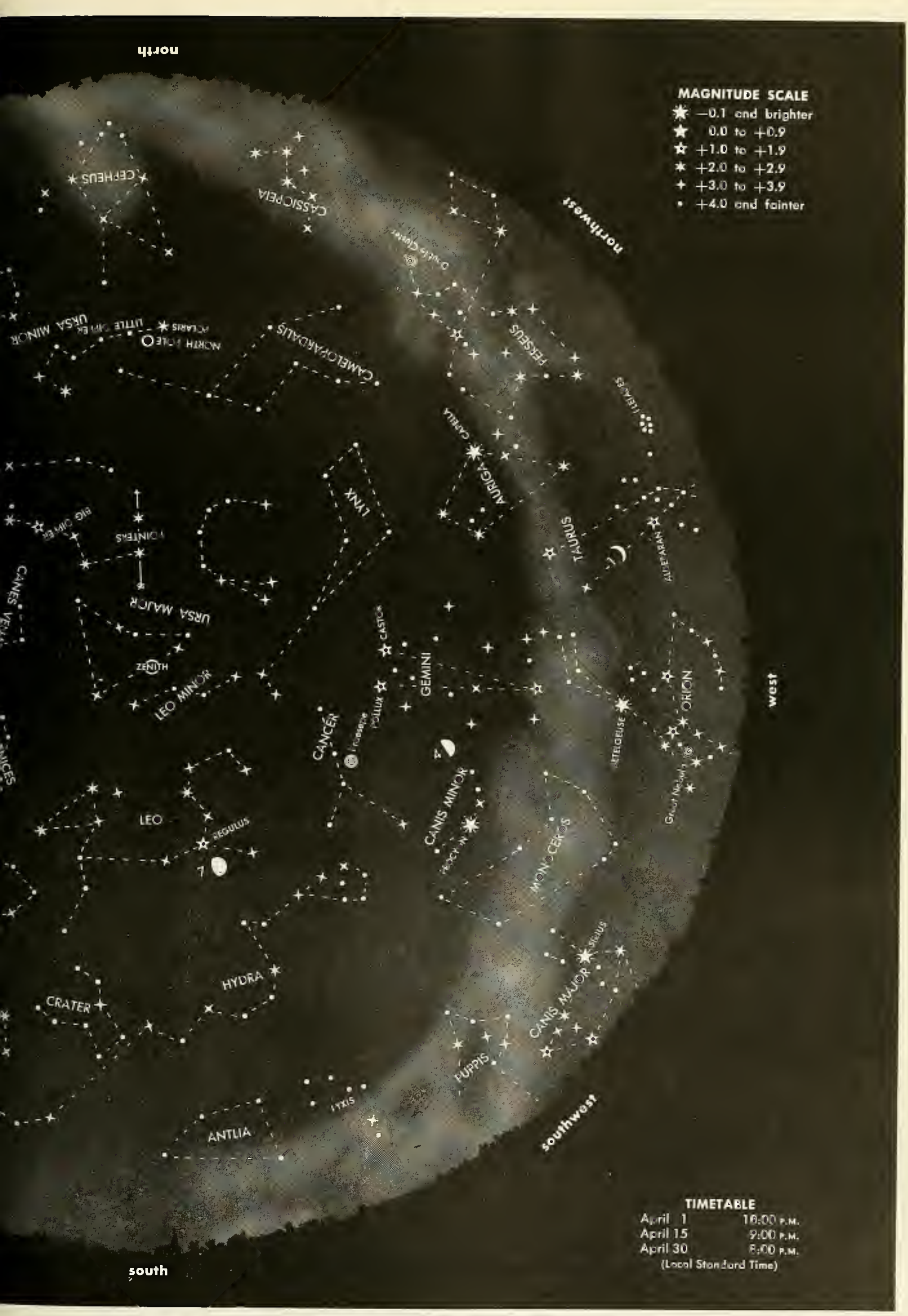
The number of Lyrid meteors seen by an individual observer at the time of maximum may vary considerably from one year to another. In the past few years, it has been of the order of twenty per hour. The number depends also on the latitude of the observer. For example, fewer meteors are seen where the radiant is low in the sky, because atmospheric extinction obliterates the fainter ones. Finally, the presence of bright moonlight also has the effect of dimming the meteors' brightness. In this respect, however, the 1960 Lyrids will be favored by a nearly moonless sky, because the moon will be four days past last quarter on April 22, and will rise in the latter part of the night.

The Lyrid meteor shower is associated with the comet 1861$^{\mathrm{I}}$. Historically, it is one of the first for which such an association was discovered. The particles that cause the shower have escaped from the comet whenever it has passed near the sun, and are now scattered along the comet's orbit. These particles travel through the earth's atmosphere with an average speed of thirty miles per second.

The former Astronomy Editor for NATURE Magazine, MRS. GOSSNER, continues in that role for NATURAL HISTORY.



To use this map outdoors, hold it in such a way that the direction you wish to face is printed at the bottom. The constellations depicted below the point marked "zenith" are visible in that part of the sky at the time indicated.


north
CEPHEUS
CASSIOPEIA
northwest
Double Cluster
PERSEUS
PLEIADES
URSA MINOR
LITTLE DIPPER
POLARIS
NORTH POLE
CAMELOPARDALIS
CAPELLA
AURIGA
BIG DIPPER
POINTERS
LYNX
TAURUS
ALDEBARAN
CANES VENATICI
URSA MAJOR
CASTOR
GEMINI
ZENITH
LEO MINOR
POLLUX
ORION
BETELGEUSE
west
CANCER
Praesepe
4
CANIS MINOR
PROCYON
Great Nebula
LEO
REGULUS
7
MONOCEROS
SIRIUS
HYDRA
CANIS MAJOR
CRATER
PUPPIS
PYXIS
ANTLIA
southwest
south

MAGNITUDE SCALE

- −0.1 and brighter
- 0.0 to +0.9
- +1.0 to +1.9
- +2.0 to +2.9
- +3.0 to +3.9
- +4.0 and fainter

TIMETABLE

April 1	10:00 P.M.
April 15	9:00 P.M.
April 30	8:00 P.M.

(Local Standard Time)

First Maritime Trade

The Egyptians, with the Nile's traffic as inspiration, venture

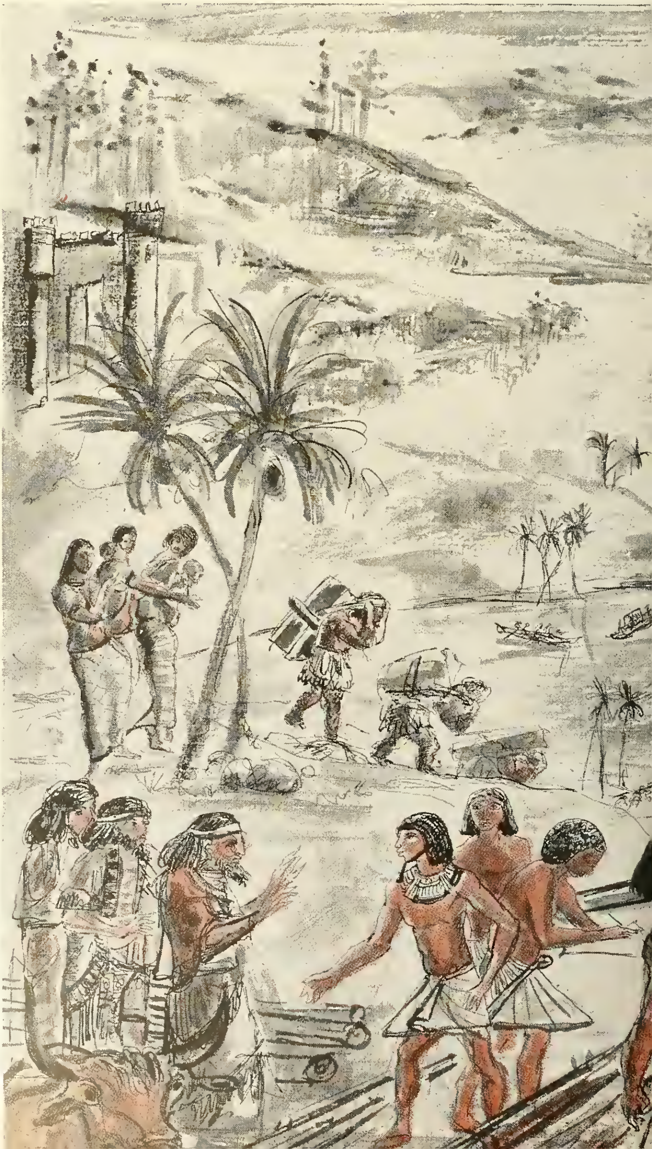
By Lionel Casson

"Bringing of forty ships filled with cedar logs." So wrote an ancient scribe in listing the accomplishments of Pharaoh Snefru. ruler of Egypt about 2900 B.C. This handful of words brings the record of man's maritime endeavors across the threshold into the period of history proper. There exists, for the first time, the strong light of written words to serve as a guide.

As in the case of so many phases of civilization, the record begins in Egypt. Very little wood grows in the valley of the Nile. Cedar most certainly does not and, to get it, Snefru had to look overseas. So he sent to Phoenicia, where a famous stand grew on the mountain slopes of Lebanon. Snefru was blazing no trail, for Egypt had been in touch with this area even before his time. Archeologists have found in the tombs of Pharaohs and nobles of earlier dynasties jars and flasks and pitchers that were made in Palestine and Syria, and they have dug up in the latter countries objects that unquestionably came out of Egyptian workshops. Were these carried overland or by boat? Before the time of Snefru there is no way of telling.

But the scribe's words remove all doubt; some three thousand years before the birth of Christ a fleet of forty vessels slipped their moorings, sailed out of a Phoenician harbor, and shaped a course for Egypt with a burden of Lebanese cedar. This is the world's first articulate record of large-scale overseas commerce.

Not far north of where Beirut stands now was the port of Byblus,

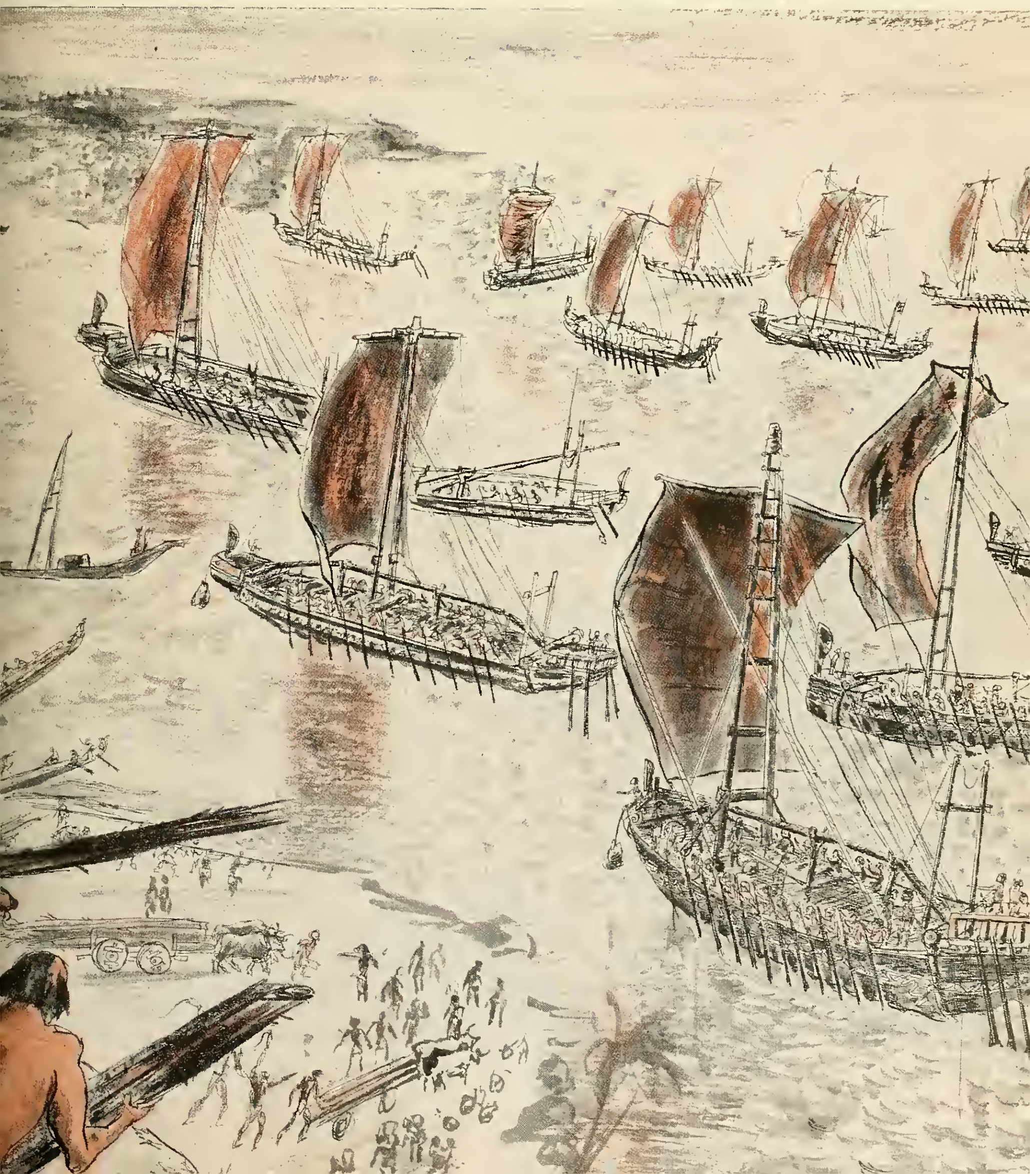


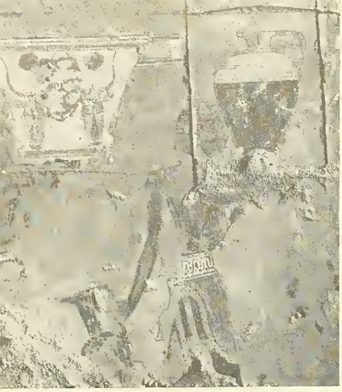
Snefru's forty ships were probably of the river traffic type seen at the right, with sail on a two-legged mast, a hawser looped around stem and stern.

n History

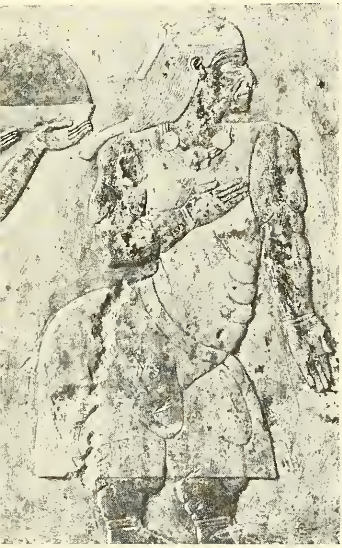
heir frail river vessels at sea

Illustrations by Hans Guggenheim





Cretan figures, marked by distinctive skirts, embellish a 1500 B.C. tomb.



Punt's queen, steatopygous and tiny, is sculpted on memorial to Hatshepsut.

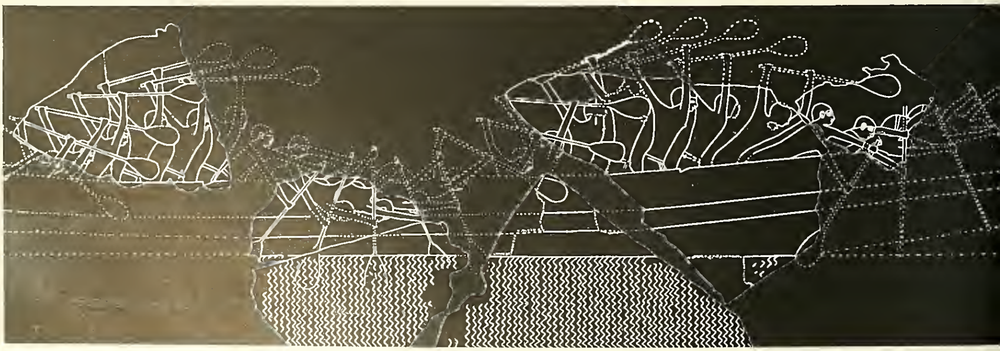
whose beginnings go back beyond recorded memory. It was here that, among other things, the timber of Lebanon in Snefru's day and for centuries thereafter was brought to be loaded for shipment, and copper from the rich deposits in Cyprus was ferried in for transshipment. So constant was the trade between this city and Egypt that from earliest times seagoing merchantmen were called "Byblus-ships" whether they actually plied between there and Egypt or not, just as in the last century "China clippers" and "East Indiamen" were used on runs other than these.

HUNDREDS of years later, when Egypt lost much of her power and could no longer maintain her overseas contacts, she felt the loss of this commerce keenly. "No one really sails north to Byblus," wailed one sage some four or five hundred years after Snefru's time. "What shall we do for cedar for our mummies, those trees with whose produce our priests were buried and with whose oil nobles were embalmed?" It was not the Egyptian shipwrights and carpenters alone who needed Lebanese timber; the undertakers wanted it too.

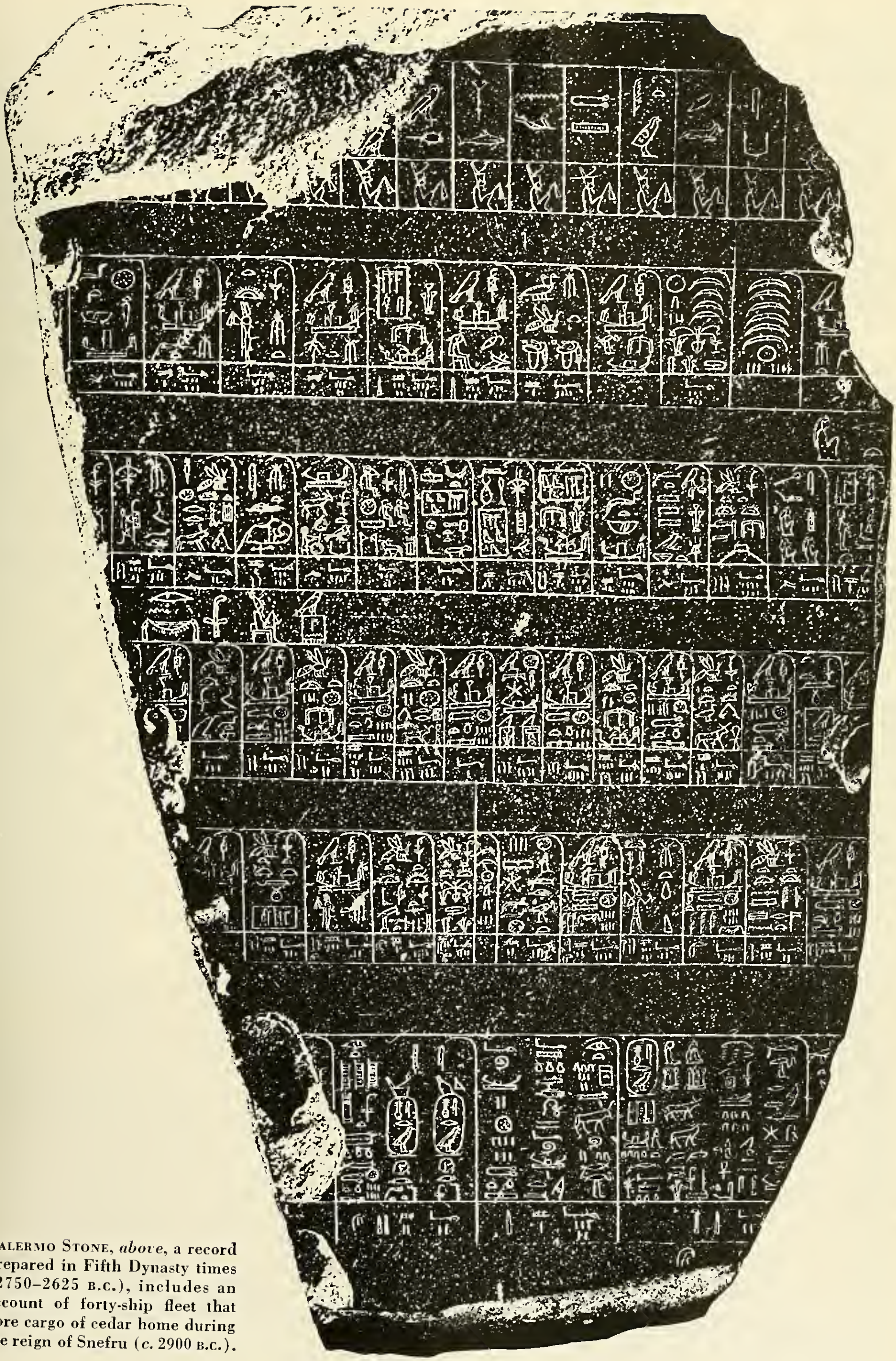
Egypt had need of imports for which she had to turn to countries other than Phoenicia. Every year, enormous amounts of incense—myrrh and frankincense—were burned on her altars. These products were available only from southern Arabia and the African coast below the Red Sea, an area which the Pharaohs' scribes called Punt and which we know today as the Hadramaut and Somaliland (*map*). For centuries, these supplies had come overland, maintained by countless small traders who passed th merchandise along from hand to han and, presumably, passed along an i crease in price at each exchange. Th earliest Pharaohs set themselves th job of cutting out these middleme In so doing they created one of th first great state-operated maritime e terprises in human history.

The task was not easy. The on alternative to the overland route w by water down the Red Sea. B Egypt's centers were all strung alon the banks of her great river—sep rated from the Red Sea at the close point by an eight-day march acro desert. The easiest route was along gorge in the desert called the Wa Hammamat. On the rocks lining it one point, Henu, minister of Pharao Mentuhotep III, some two thousan years before the birth of Christ, i scribed an account of his services the state. "My lord sent me," writes, "to despatch a ship to Punt bring him back fresh myrrh. . . . left [the Nile] with an army of 3,0 men. Every day I issued to each leathern bottle, two jars of water, 2 loaves of bread. . . . I dug 12 well . . . Then I reached the Red Sea, ma the ship and despatched it."

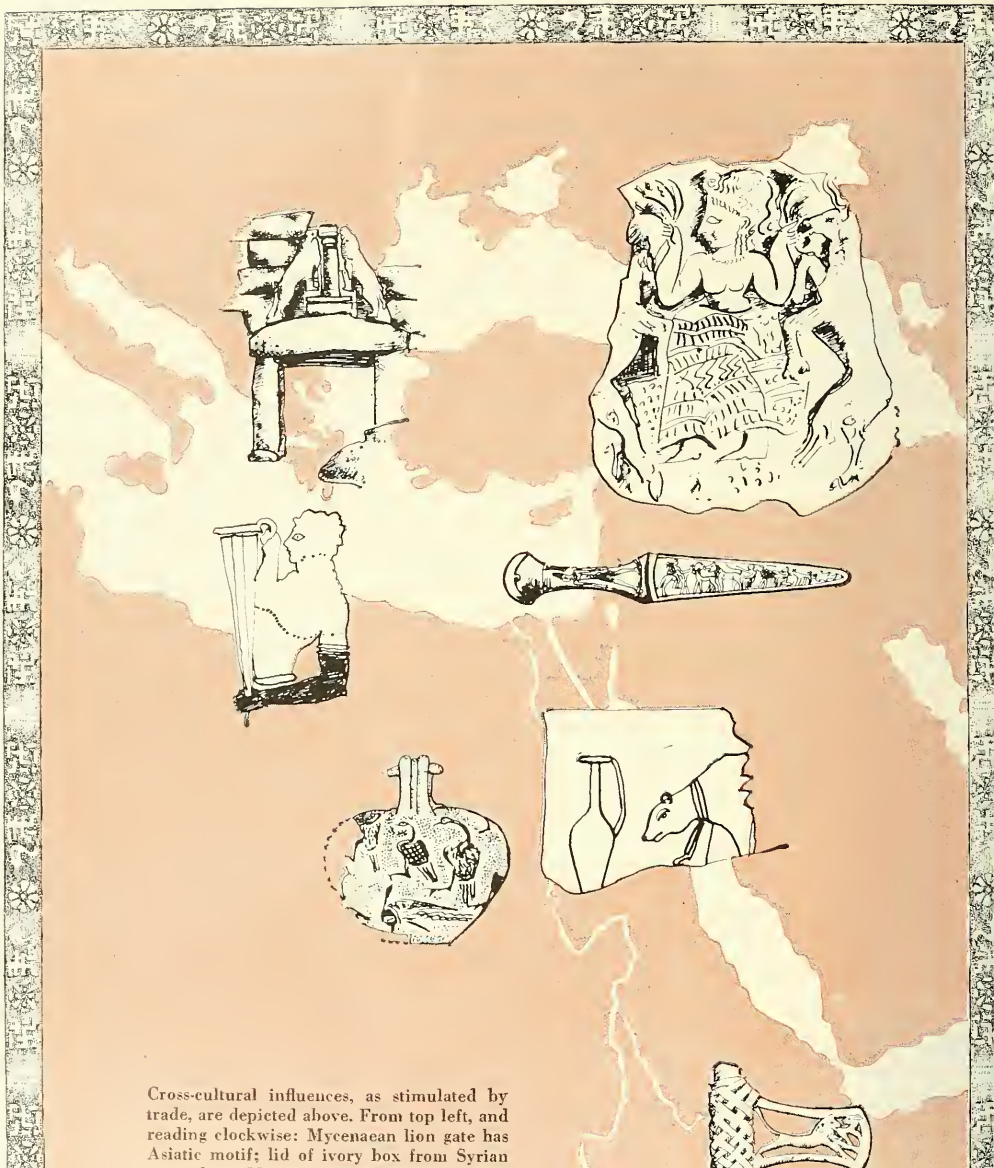
NOT very long after Henu had a complished his mission, som time in the twentieth century B. Pharaoh Senusret took a step th rendered such an assignment fro then on unnecessary: he dug a can from the northern end of the Nile the Red Sea. Cargoes this way we spared both the wearying carava trip and the work of transshippin every item from ship to donkey a then from donkey to riverboat.



Boating scene, which decorates temple of Userkaf, first of the Fifth Dynasty kings, shows this detail of the odd, centipede-like stroke—from a standing position to a dee crouch—that paddlers used. Dotted lines show restoratio



Palermo Stone, *above*, a record prepared in Fifth Dynasty times (2750–2625 B.C.), includes an account of forty-ship fleet that bore cargo of cedar home during the reign of Snefru (*c.* 2900 B.C.).



Cross-cultural influences, as stimulated by trade, are depicted above. From top left, and reading clockwise: Mycenaean lion gate has Asiatic motif; lid of ivory box from Syrian coast shows Minoan custom of dress, despite Asian carving; gold dagger and sheath from Byblus show Egyptian motifs; bear and one-handled flask from Egyptian tomb are Syrian touch; ax is typical of ones traded at Punt; dolphin at bottom of Lisht jar was borrowed from Minoan wall paintings; cupbearer from Knossos shows the conventional Egyptian eye.

NEAR the famous valley across the river from Thebes, where so any of the Pharaohs dug their mbs, stands the huge temple of eir-el-Bahari. It is a monument ected shortly after 1500 B.C. by atshepsut, the first great queen of story. On its walls she carved a rec- d, with magnificent illustrations, of e of the great achievements of her le, a large-scale voyage to Punt.

Many years before Hatshepsut's ign, Egypt had fallen upon diffi- lties. Civil war had split the coun- r, and the fragments were ruled by start princelings or by invaders. one was in a position to maintain project as sizable as the Red Sea et. Senusret's canal was abandoned d gradually silted up. The ship- ng of incense, as in centuries be- re, was once again carried on over- nd through middlemen. But, by 70 B.C., a new dynasty arose that nited the country, established a m rule, and inaugurated an age at was to be Egypt's most cele- ated. The fifth member of the line as Hatshepsut. Her contribution, as fits a woman, was an act of peace: e restored direct maritime connec- ons with distant Punt.

On one of the walls of the queen's mb-temple, exquisitely carved in v relief, the story of her expedi- n is told. We see a fleet entering e harbor at Punt: three sleek, an-lined vessels are still under ay, their great sails bellying with nd. Two others have doused their nvas and are ready to tie up. Next the disembarkation: an Egyptian royal messenger heads a file of men and offers a heap of familiar objects of barter—necklaces, hatchets, daggers—to the king of Punt, who advances to meet him, followed by an enormously fat wife, two sons, and a daughter. Then ensues a scene of frenetic activity as a long line of Puntites brings the products of the country to the tent of the royal messenger, while another file carries jars and myrrh trees up gangplanks onto the visiting vessels.

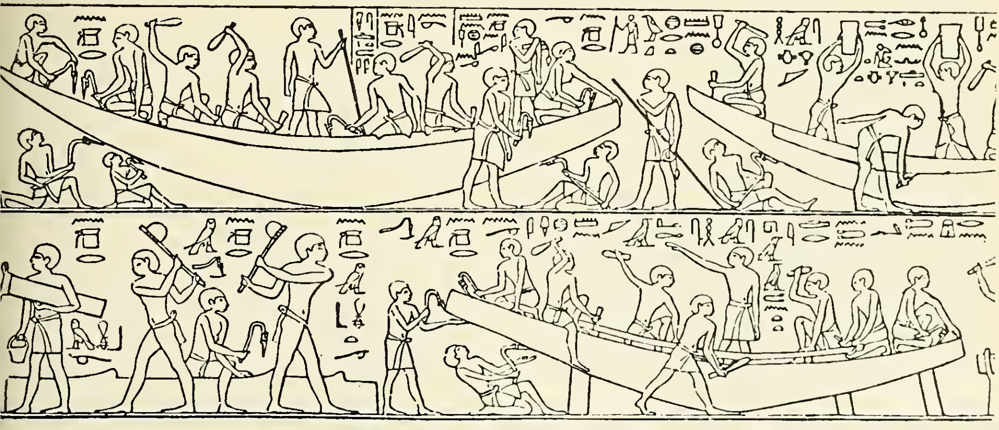
Then comes the departure, the ships leaving the harbor under full sail, their decks piled high with cargo. Each scene has a caption to describe it down to the minutest details of action ("Hard to port!" calls the pilot of one of the ships as they maneuver; "Watch your step!" is carved over the stevedores in the loading scene), and from them an almost complete cargo manifest can be compiled. It is imposing: various woods, including ebony, myrrh-resin, live myrrh trees, ivory, gold, eye cosmetic, skins, 3,300 head of cattle, natives, and their children. And some souvenirs of the distant land: native spears, apes, monkeys, dogs; even ". . . a southern panther alive, captured for Her Majesty."

THE vessels shown on Hatshepsut's reliefs represent the height of the Egyptian shipbuilder's skill. Yet, though they are fine-looking ships, their design had serious weaknesses and, for good reason, was not to play an important role in the history of naval architecture.

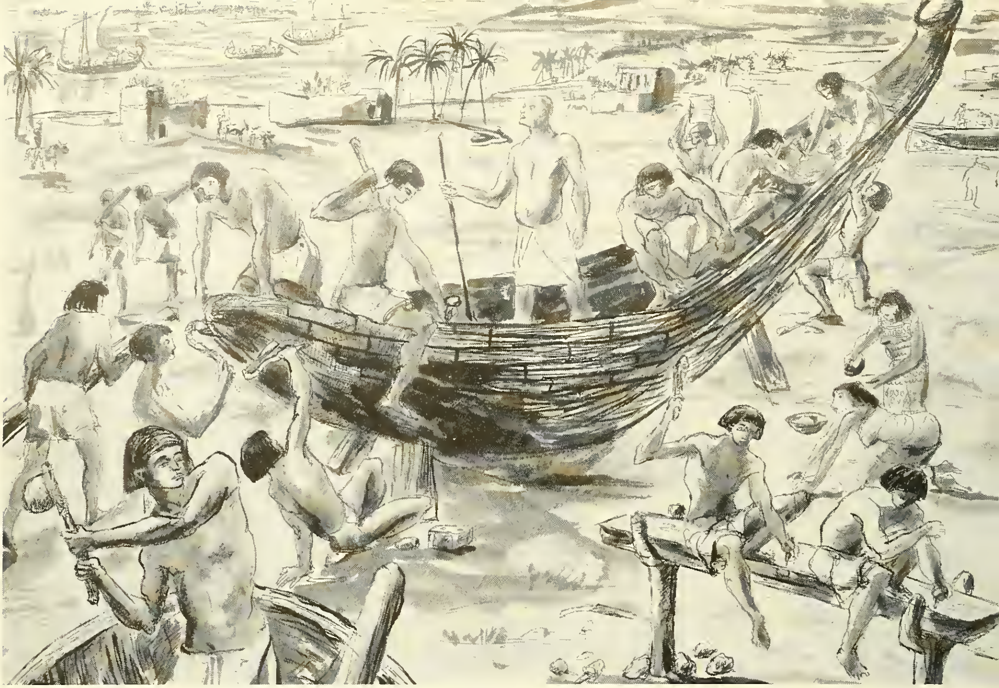
In Egypt, stretched like a ribbon along the banks of a river that offered a clear course of over four hundred miles, it was natural that the designing and sailing of boats would begin early and develop rapidly. The Nile offered the best and easiest highway. It was even blessed with a prevailing wind that blew from the north: one could sail upstream and then drift back downstream—or row, if in a hurry.

The tombs of Egypt have yielded pictures and even models of a bewildering variety of river craft, from tiny rowboats, through swift yachts and dispatch boats, to enormous barges that were built to carry huge obelisks, weighing hundreds of tons, from the granite quarries far upstream. Life on the ancient Nile must have been every bit as varied and picturesque as on Mark Twain's Mississippi. And, as designers of river craft, the Egyptians were unsurpassed. This was their weakness: when they turned to the design of sea-going ships, they simply constructed oversize Nile boats.

In building ships, in almost all times and places, people have used a framework of keel and ribs. The keel was the spine; the ribs curved upward and outward from it, and to them a skin of planks was made fast. In this way, strength and rigidity were imparted. Not so the Egyptians. Building for use on a river where storms, violent winds, battering waves, or ripping currents were rare, they constructed even their largest vessels without a keel and with few,

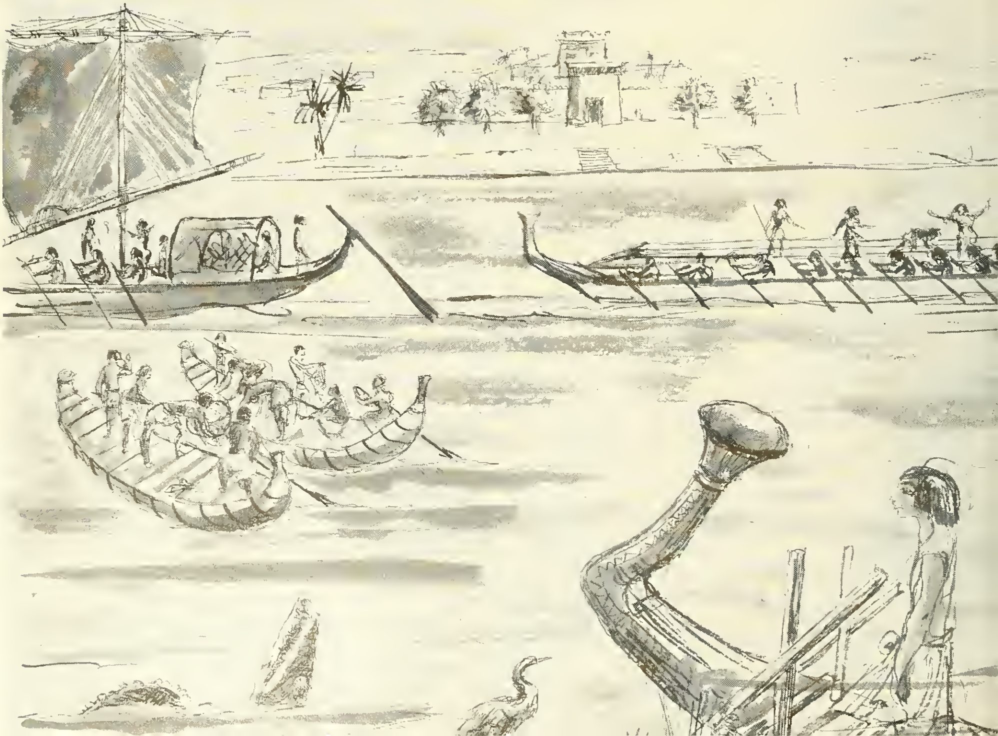


HIPYARD SCENE, of Old Kingdom date (2980-2475 B.C.), is beehive of activity. Pair with stone mauls, at lower left, are presumably splitting a timber balk, on which an adzman sits astride, into planking. Good wood had to be imported.



Reconstructed detail from shipyard scene shows laborers, *above,* smoothing the hull planking of a small river vessel.

Nile traffic, *below,* included fishermen's papyrus cano at left; quarry barges, center; rich pleasure craft, rig



ry light ribs. The planks of the n were pinned to one another, ra- er than to a skeleton. The only ffening provided, beyond the hand- . of ribs, consisted of beams run om gunwale to gunwale, on which e deck was laid. This was adequate : a river. A good deal more was eded for a ship that went to sea.

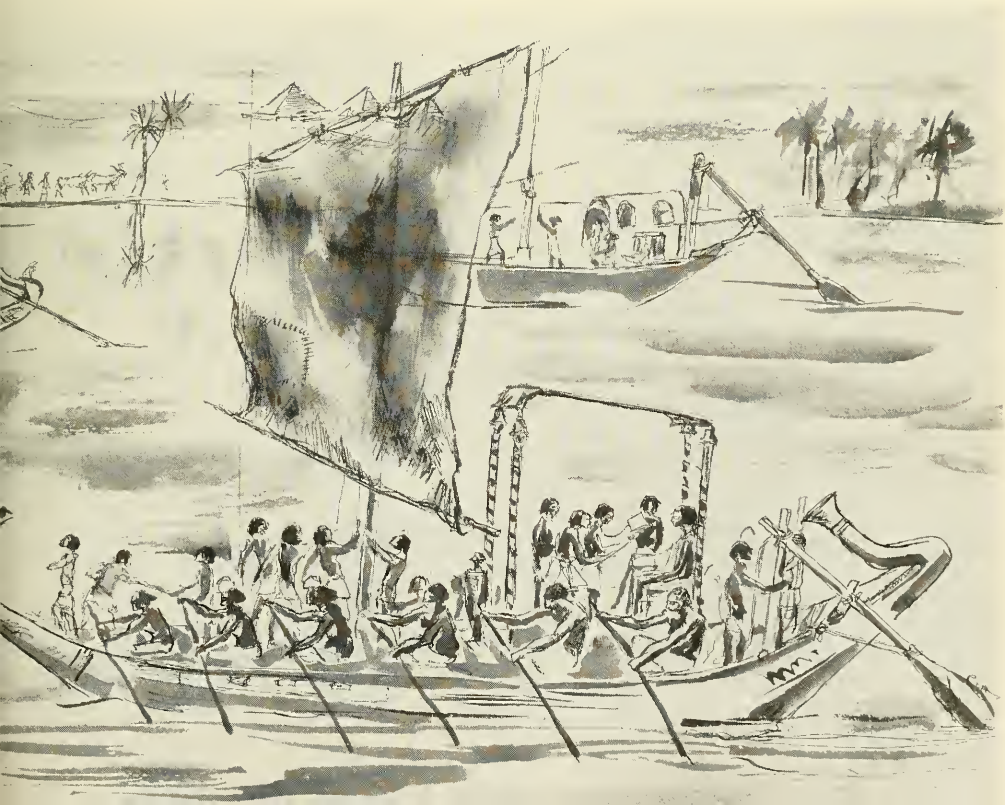
ABOUT 2550 B.C., Pharaoh Sahure built a fleet of transports to ry his troops to some Asiatic coast. e event is commemorated on the lls of his pyramid, thereby leav- g the earliest clear picture of sea- ing ships extant. So carefully did e artists execute their assignment it almost every detail of construc- n appears; we can see precisely at the Egyptian naval architect l to adapt for use on the sea a boat sically built for a river.

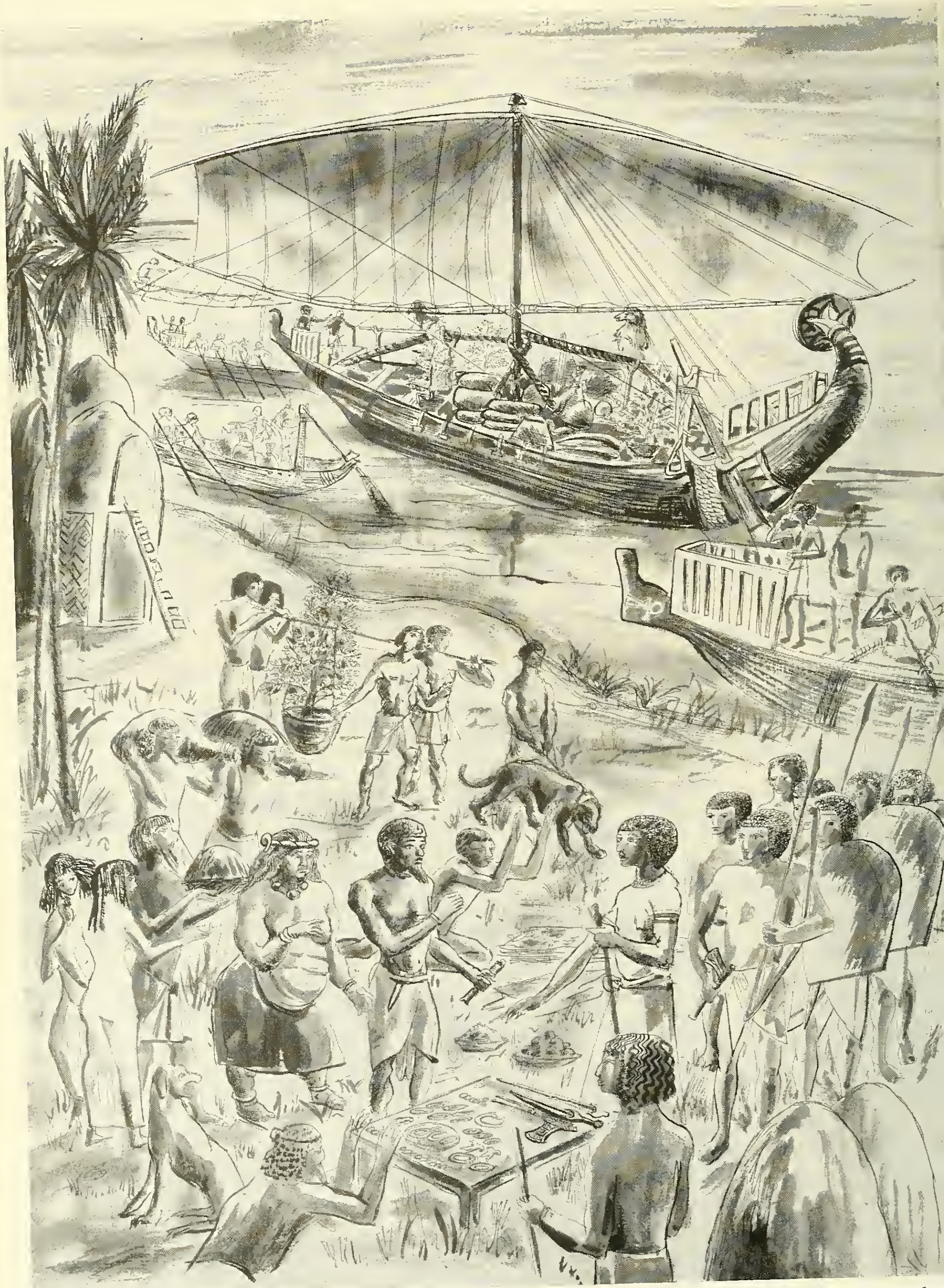
Around the bow of the vessel, he ped an enormous hawser, carried along the centerline above the ck, and looped it about the stern. placing a pole through the strands the hawser where it passed over e deck, and twisting, one could tighten the whole harness like a tourniquet. This was his substitute for keel and ribs: twisted until it had the proper tension, the hawser held the ends from breaking off when the vessel was forced to batter her way through heavy seas.

The architect could not use an ordinary, single mast, for there was no keel in which to sink its butt securely (the heel of a mast exerts tremendous leverage against its socket). So he designed a two-legged mast, which distributed the pressure, and he stayed it carefully with lines fore and aft. On this, a tall slender square sail was mounted, in a fashion peculiar to Egypt: two yards spread it, the usual one along the head and another along the foot.

But the ship was not solely a sailing vessel: when there was no wind, or when it was foul, sail was taken in, the mast was lowered and rowers sent her on her way. The Egyptian artists in their scrupulous attention to detail have added a homely touch that permits us to figure out what kind of stroke the rowers used. Oarsmen are always pictured with a special type of loincloth, one made of a netted material with a square patch of solid leather on the seat. This obviously was chafing gear: the rower must have handled his oar the way they did in the Middle Ages, rising to his feet at each stroke and throwing himself on the seat with the pull: without a sturdy patch on his rear, he would have rubbed through his loincloth in short order.

A thousand years later, naval architects were designing the ships shown on Hatshepsut's reliefs. They are cleaner and faster than Sahure's. Their lines have the graceful curves of a racing yacht. The sail has given way to one much larger but no longer tall. Enormously broad instead, it was still spread in the old manner by a yard along the foot as well as along the head. It was so wide that the yards were made of two tapering spars, with their butts fished together. The broad sail has permitted the use of a much shorter mast, one that exerts less leverage, and the architect has accordingly given up the old, two-legged arrangement for a single pole.





Hatshepsut's ships, shown here receiving cargo at Punt, were Egypt's finest. Stubby, single mast supported a low, wide sail of great area: lines of hull were clean and r
But the great hawser, a substitute hull-stiffener, remai

But except for these points—im- ovements rather than radical changes design—almost everything else is as fore. The keelless vessel, with its ndful of light ribs, must still be held gether by a heavy hawser looped out the ends and twisted to the prop- tension. These boats were beautiful; questionably they were fast; but ey sadly lacked sturdiness. We shall t see them outside Egypt.

HE peak of Egyptian expansion was reached in the reign of tshepsut's successor, Thutmose III, rhaps the greatest of the Pharaohs. was he who extended Egypt's arm er Palestine, Syria, and Phoenicia. d even beyond to the countries in- d. He carried out his conquest and ganization of the areas so thor- ghly that his successors were able coast for centuries on his doings. For the next three hundred years, til about 1200 B.C., Egypt's trade urished as never before. Vessels m the Levant dumped on her ys everything from ponderous bers to the finest and most deli- e objects of Asiatic craftmanship. e Pharaohs and their courts rode chariots that had been made in ria, raised cattle that came from ia Minor, ate delicacies that were wn on the island of Cyprus, and re served by swarms of Asiatic and nitic slaves. Their wives dressed gorgeous stuffs from Syria and nted themselves with the perfumes southern Arabia. Punt provided, always, its stores of incense, ivory, l rare woods. Copper came from prus and silver from Asia Minor. In return, Egypt sent out gold that s mined upriver in Nubia, papy- made into sheets for writing er or twisted into cordage, linen tiles, and the fine products of her rkshops—beads, faience, scarabs, urines. A king of Cyprus, who had plied the Pharaoh with copper l timber, writes to ask for horses, ariots, a bed of rare wood all gold- ted, women's dresses, jars of oil fine quality. In another letter, he uests an Egyptian specialty that y not have been as unusual as it nds—a sorcerer; this one had to an expert with eagles. Trade was h that merchants from overseas ablished residences in Egypt. In great city of Memphis a foreign arter sprang up—complete, as h places always are, with temples the strangers' gods.

Kenamon was an official under Amenhotep III, charged, among other things, with the Levant commerce. He had a picture painted on one side of his tomb, complete to the last detail, showing a typical moment in an Egyptian harbor fourteen centuries before Christ.

A fleet of ships has just arrived. One can tell where they are from by the dress and looks of the skippers and mates, who wear gaily embroidered, ankle-length robes and have full beards and prominent, hooked profiles. They are unquestionably Semites. The vessels, consequently, must be from Syria and Phoenicia, perhaps even from Byblus itself. Are the ships, too, foreign or are they Egyptian? With their gracefully curved bow and stern and prominent overhang fore and aft, they seem very like Hatshepsut's vessels. Yet they lack the telltale looped hawser. Perhaps it is the artist's fault: as an Egyptian, he may have unconsciously grafted a native look on to ships that were really foreign.

A number of the ships are already made fast, their sails furled, the boarding ladders lowered from their prows to the shore. Harbors were rough-and-ready affairs in those days; since there were no wharves, ships were simply run up on the beach. Other vessels are shown making ready to land. Sailors have sprung aloft to take in canvas and, on one, the skipper stands in the bow carefully taking soundings as the ship inches in toward the beach.

ON shore, everything is bustling. An Egyptian customs official, standing before an officer and file of men from one of the ships, is entering information about them on a tablet. One Egyptian tradesman is busy trying to sell his wares; he points with emphasis to his scale to assure prospective customers that it is accurate. Another is actually transacting a piece of business with one of the ships' officers. The latter is trying to sell a large jar, probably of wine or oil; for no good grade of either was ever produced in Egypt; behind this officer, a file of hands unloads several more jars.

In one corner of the panel, a ship's officer leads two women and a child before an Egyptian official. Are they slaves? In another corner is the procession before Kenamon himself: men from the ships stolidly file before him with wares of all sorts, while their officers grovel in the dirt before the great man.

PROFESSOR CASSON, of the Classics Department at New York University, is the author of a current volume, *The Ancient Mariners* (Macmillan), from which this article is excerpted. MR. GUGGENHEIM, the illustrator, has regularly contributed to these pages.

Active as Egypt's trade was, it had strict limits. Her lightly built ships raced south to Punt and north to the Levant but very likely not much farther. Many of the products the Egyptians imported and exported were carried in foreign bottoms, like those in Kenamon's picture. The distinction of being the first great traders of the Mediterranean goes to another people, a race of born sea sailors rather than foolhardy rivermen.

SOME decades before Kenamon, a noble named Rekhmire, vizier of Egypt and second in importance only to the Pharaoh, ordered pictures for his tomb showing all the world paying tribute to his master, the great Thutmose III. As in Kenamon's picture, there appear Semites from Phoenicia and Syria. There are men from the south, Negroes from the Sudan and people from Punt. Alongside these by now familiar figures appear others that are completely new. They wear unusually decorated kilts and queer sandals, and do their hair in a strange fashion. The bowls and other vessels they carry have unfamiliar shapes. "The People of the Isles in the midst of the Sea," the caption calls them.

"Minos is the first to whom tradition ascribes the possession of a navy. He made himself master of a great part of what is now termed the Hellenic Sea; he conquered the isles of the Aegean and was the first colonizer of most of them." So wrote Thucydides, one of the most sober and scientific historians who ever existed, in the fifth century B.C., some thousand years after the times of Thutmose and Rekhmire. Minoan traders have left a trail of their pottery in Palestine and Syria and Asia Minor in the east. They reached north as far as Macedonia. Southward, they knew other parts of Africa besides Egypt. One of the signs found among their carvings is a representation of a plant, highly prized in ancient days as a medicine and spice, that grew only in one particular spot on the coast of Libya. A tiny seal found in their ruins shows a kneeling camel: another, an ostrich. To the west, they pushed as far as Sardinia: ingots of copper, stamped with the telltale Minoan double-ax, have been found there. Sicily they knew well: objects made of liparite, a rare form of stone originating only in the islets off Sicily, have been found on Crete. Legend says Minos, himself, died on Sicily.

Our knowledge of the objects of Minoan trade is lopsided because the evidence is limited almost entirely to the sort of things the archeologist can dig up. Yet enough has been found to show that the outside world clamored for the products of Cretan workshops. Alike among the highly civilized nobles of Egypt and Phoenicia and the semibarbaric chieftains of Greece, there were those who preferred to eat off dishes decorated in the Minoan fashion, to carry Minoan-style weapons in battle, and to wear Minoan jewels and garments of Minoan textiles in court. The women of Crete wore a tight bodice of sorts and a bell-shaped skirt, made up in a number of tiers: in an Egyptian tomb painting, a Semitic princess appears wearing precisely such a skirt, and the skirt reappears in the harbor scene of Kenamon's tomb. (See opposite page.)

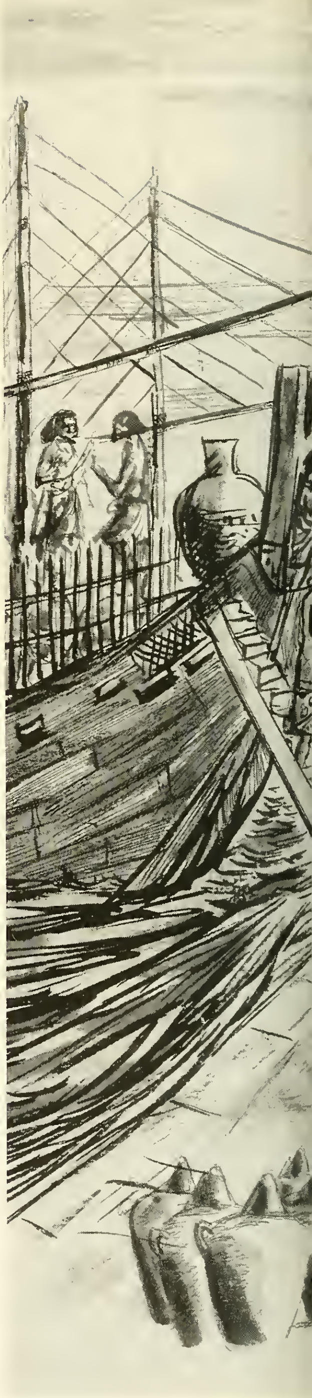
In return, the Minoans imported many things: gold, beads, faience, figurines, and probably papyrus from Egypt; copper from Cyprus; ivory from Syria; porphyry from Greece. Amber, following routes across Europe from the Baltic, made its way to their workshops.

The inhabitants of Minoan Crete were, then, the first great sea power of the Mediterranean, the first to explore that great sea in a fruitful way and to lay out trade lines that were destined to last for millennia. Must they not, therefore, be the "People of the Isles" on the wall of Rekhmire's tomb? The figures there wear their hair in the same manner as the men that appear in Cretan murals and they carry vases shaped and decorated like those found in Minoan sites. Can we not conclude without further ado that these "People of the Isles" came from Crete? The problem is not quite that easily solved.

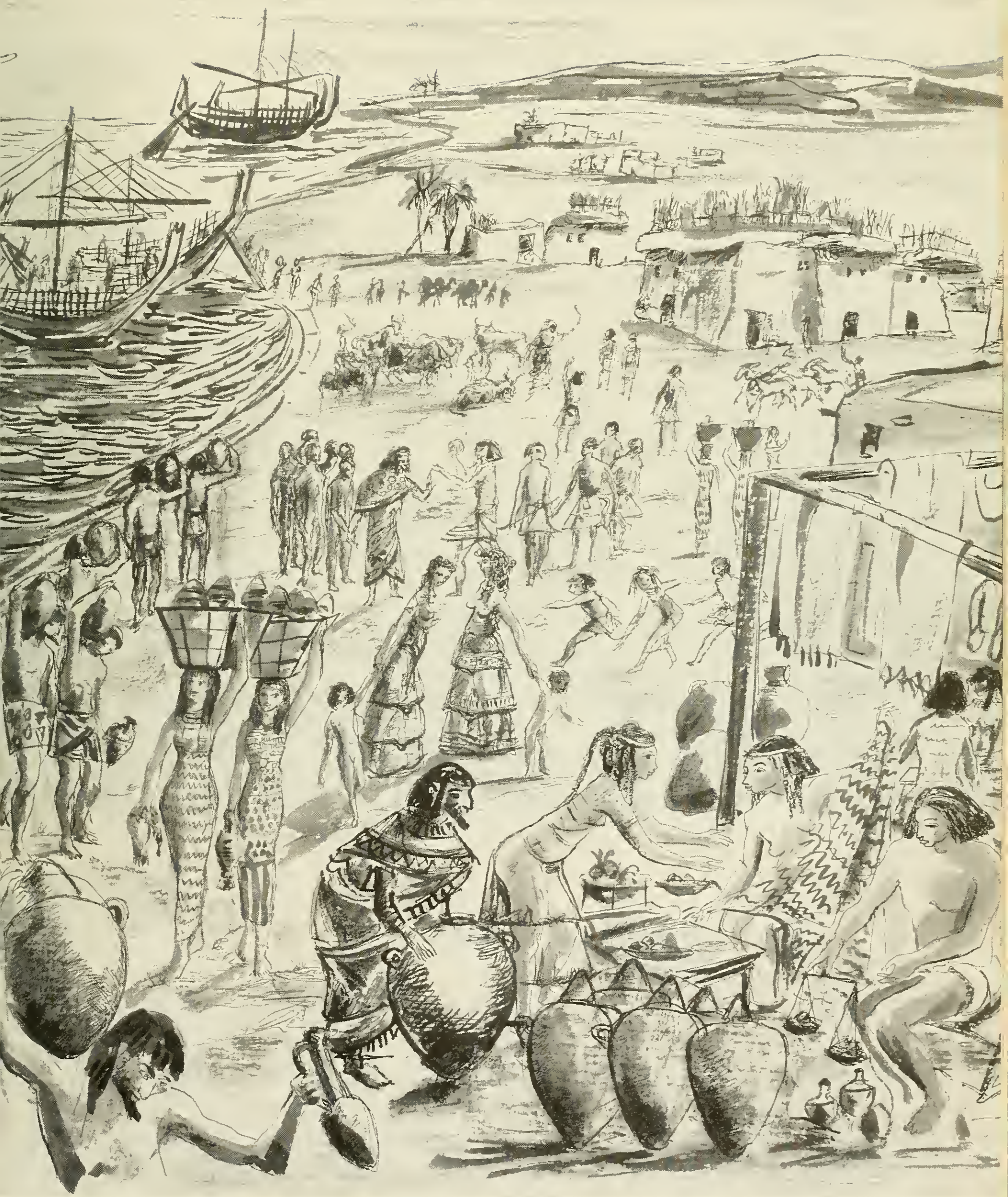
No more than a day's sail from Minos' palace in Crete lies the southern portion of the peninsula of Greece. Early in their history, Cretan traders had made their way here. The effect of their arrival was startling. The local inhabitants gobbled up Minoan civilization as avidly as Japan in the nineteenth century did that of the Occident. Their whole lives were transformed. They decorated the walls of their houses, their pots and dishware in the Minoan manner. They fashioned the same sort of seals and jewelry, wore the same sort of armor, dressed in the Minoan style. The women did their hair *à la minoenne* and looked to Crete for their fashions the way we do to Paris and Rome. Much of what was native disappeared under an overlay of culture imported from Crete.

In due course, these barbarian Greeks established themselves as heirs to the Minoans' maritime empire. They seized and held Crete, with its fine location astride the trade routes. They set up their own colonies: near Syracuse in Sicily and Tarentum in Italy; on Rhodes; on Cyprus; along the Phoenician coast. Their cities in the homeland grew rich—especially Mycenae where, in later days, Homer's King Agamemnon ruled. This was the first of their centers to be excavated and, as a result, scholars refer to the Greeks of this time as Mycenaeans and the period as the Mycenaean Age. From almost the middle of the second millennium B.C. to its end, they were the trading nation par excellence of the Mediterranean. "The People of the Isles" in Rekhmire's tomb and in other Egyptian paintings may have been Minoans, but it is just as likely—the frescoes all date in the fifteenth century B.C.—that they were the venturesome Mycenaeans, instead.

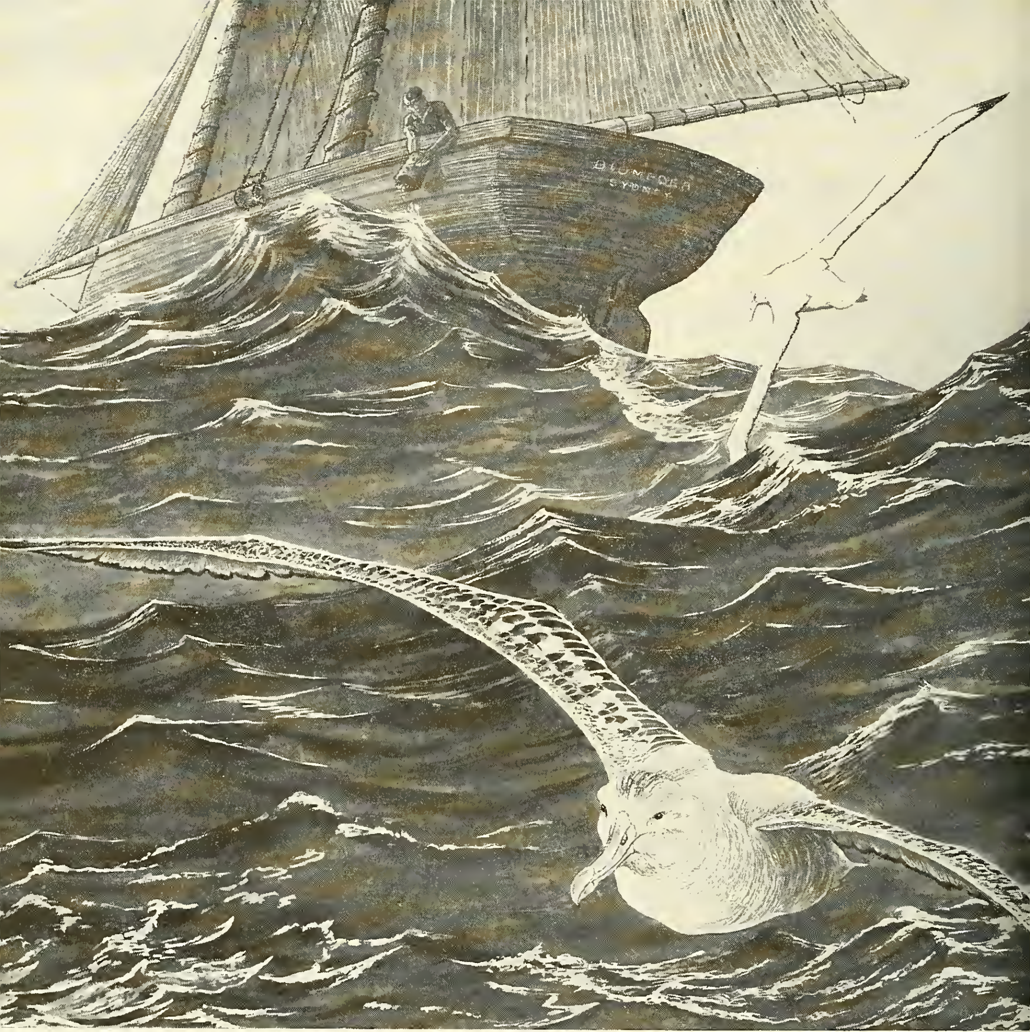
The lords of Mycenae, like their Minoan predecessors, were rich and powerful men. They were able to build grand palaces to live in and sumptuous tombs to be laid away in. In them, excavators have found the rich trappings of their daily life. They fought in beautifully wrought armor, drove in handsome chariots, wore fine clothes, and dressed their wives in style. They fed from magnificent dinnerware and drank from superb, golden goblets. The age was a great one, great enough to linger in men's memories long after its end—for it was of the last days of the Mycenaeans that Homer sang.



Reconstructed detail from Egyptia
tomb painting depicts the arrival



gn fleet during the fourteenth ʏ B.C., when Pharaohs' seapower had declined. These ships do not show the looped hawser that marked Egypt's vessels. Levantine merchantmen, they unload a cargo of oil or wine in jars.



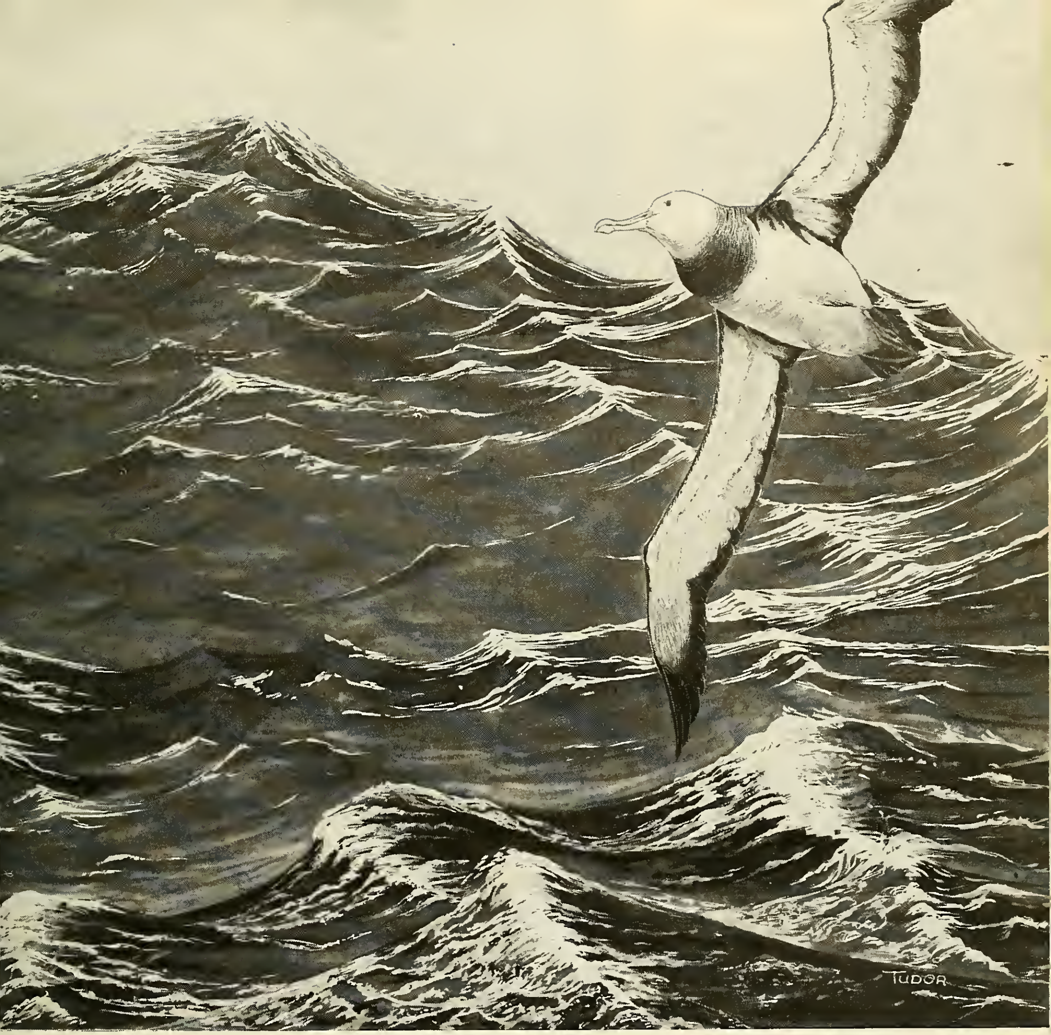
Flight of The Albatross

Sea wanderer is master of aerodynamics

By WILLIAM JAMESON

THERE ARE SOME fourteen sub
cies of albatrosses, of which t
three, or four (science still differs
their exact classification) are
"great" albatrosses. By common c
sent the greatest of them all is the W
dering Albatross. Sailors have ca
it by a variety of names—Goney, C
Sheep. Chocolate Albatross, Man
War Bird, Toroa. It features in
catalogue of birds of the British
seum as *Diomedea exulans.*

D. exulans is the largest of fly
creatures, although its dimensi
have often been exaggerated. A la
number, accurately measured, gav
tip-to-tip wing dimension averag



THE ALBATROSS, floating easily over wind-whipped waters of the Southern Ocean, may accompany a ship for many miles to seize discarded food scraps.

ver ten feet (very big ones, in-
ly males, running up to twelve
The length from tip to tail is
four feet. Weights up to twenty-
d three-quarters pounds for a
and twenty and three-quarters
s for a female are known, but
en to twenty pounds would be
l average.

n in an age that attaches great
tance to records, it is not the
f the Wandering Albatross that
it so remarkable. The never-
g source of wonder is the extra-
ry ease of its flight: a bird, as
a swan and weighing perhaps
pounds, that swims through the air as easily as a trout in a quiet pool.

The albatross, more than any other bird, has the habit of following ships. It would be nice to think that they crave company in the loneliness of the ocean, but the facts are more prosaic. Scraps thrown overboard make a pleasant change, and their usual diet (squids and shrimps) is brought conveniently to the surface by the turbulence of a vessel's wake.

All agree that immense distances can be covered by albatrosses, though proven information about a bird that spends most of its time in rarely visited places is hard to come by. I have a photograph, taken in 1940, of a Wanderer with distinctive white-tipped primaries, which followed H.M.S. *York* for four successive days, during which the cruiser, steaming at eighteen knots, covered over 1,700 miles. A Wandering Albatross shot off the coast of Chile had a small vial hanging on a cord from its neck. In it was a message, only twelve days old, from the whaler *Euphrates* in New Zealand waters, 3,150 miles away on a great circle course. A bird ringed on Kerguelen Island was recaptured near

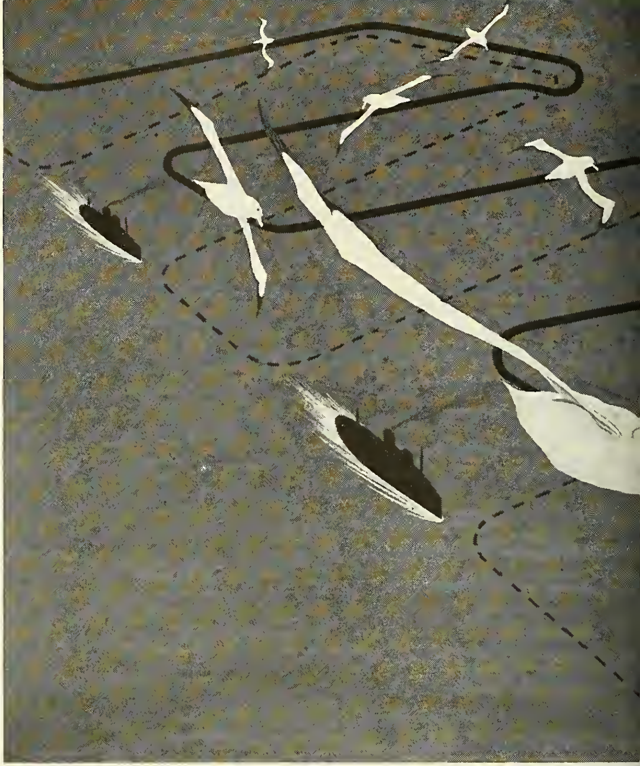
Cape Horn, 6,083 miles from the point of release, by the French four-master *A.D. Bodes*. Yet the birds that cover these vast distances hardly ever seem to flap their wings, for the most remarkable thing about the albatross is its seemingly effortless flight. How does the bird do it?

IMAGINE a typical Southern Ocean day in the Roaring Forties. The wind is blowing strongly from the west—seven to eight on the Beaufort Scale (thirty-five to forty-two miles per hour). The sea, rolling eastward at about twenty miles per hour, has not yet risen with the wind, but there is a long swell left over from a recent gale. The waves are one hundred yards from crest to crest, with troughs some fifteen feet deep. Our ship, steaming southward with the wind and sea on the beam, is rolling heavily. A single Wandering Albatross is in company and, as I come on deck, it is some fifty-five feet up on the starboard quarter, just to windward of the broad lane of disturbed water spread by our passage over the heaving waves astern.

The bird is overtaking us rapidly. As I watch, it turns downwind across the wake, "reefs" its wings into a shallow W and dives rapidly to leeward. Moving fast through the air and with the wind behind it, its speed over the water is very high. In a few seconds, it is well to leeward, turning north and vanishing in a trough between the waves as it banks steeply just above the sea. A few seconds later, it emerges several hundred yards away on the port beam, facing the wind on fully extended wings and rising. This leg of its flight track—against the wind—takes rather longer, but the albatross has soon crossed the wake again, turned south on to the same course as the ship and is back in its original position—fifty-five feet up on the starboard quarter.

For over an hour I watch the albatross, flying on this same curved flight path and returning at perfectly regular intervals to the same position. Not once do I see it flap its wings. How does the bird regain the height it loses in its downward swoop to water level? Why is it not swept bodily away to leeward by the forty-mile-per-hour wind?

The albatross is, of course, capable of powered flight, but it is as a glider that it is so remarkable. Let us consider the constructional details of a typical sailplane and see in what ways its layout compares with that of a Wandering Albatross.



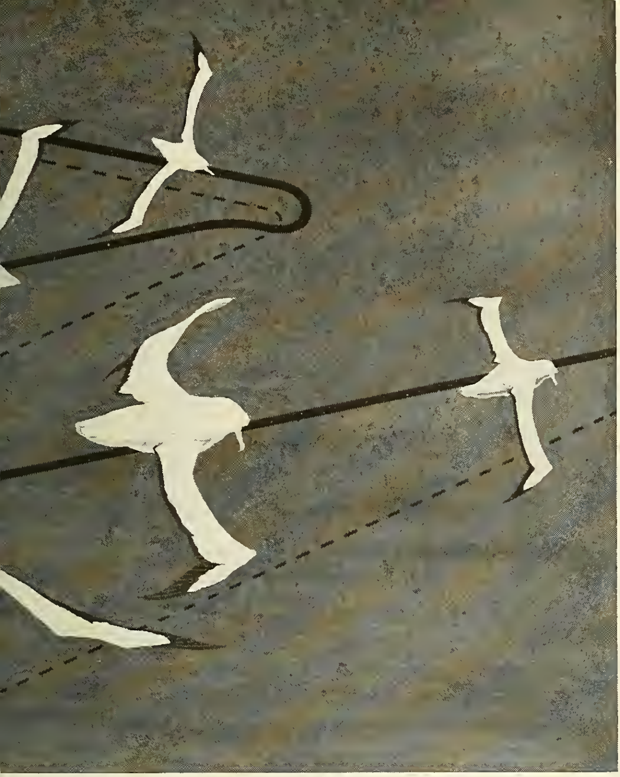
ALBATROSS, in accompanying a vessel, follows a repetitive pattern of flight.

From a position off ship's starbo quarter, bird makes dive to leew

The motive power of a sailplane is the force of gravity: it must use this power to the best advantage, traveling forward as far as possible with the minimum loss of height. The wings must therefore give the required lift with the minimum drag. Wind-tunnel experiments, backed by practical experience, have proved that long, narrow, tapered wings give the best results. The ratio between the average width of the wing and its length must be high. This aspect ratio, in a high-performance sailplane, is around eighteen—the same as that of the Wandering Albatross. The lift/drag ratio of such a wing, considered alone, may be as high as forty to one: that is, for every forty pounds of lift acting upward at right angles to the wing there is a resistance to forward motion of a pound.

Even with the best modern materials and technique, it is not easy to build a sailplane with such long narrow wings and with the requ lightness and strength. In the a tross, nature has solved the prob notably by providing the bird hollow wing bones, filled with ai stead of marrow. The bones of a are very strong for their weight. skeleton of an albatross—with a weight of twenty pounds—scales under three pounds, including breast bones, back, head, neck, b skull, legs, and feet.

SCIENTIFIC studies extending many years have determined best section and form for the plane's wing and wing-loading gives the highest lift/drag ratio. sailplane the dimensions and f used must be a compromise, as best shape and size for low speed different from that required at speeds. Here the bird has a g advantage over the machine. Its is a living entity; the bones are ri but the feathers and joints are trolled by muscles and can be mo



g in a few seconds to parallel course. It then swings toward

ship, wings fully extended, and rises into wind to regain initial position.

ng a wide variation in the
and area of the wing in flight.
ing a flying albatross through
, one sees that not only the
f the wings, but their camber,
ack, and dihedral are con-
being changed. By opening or
the feathers fanwise, the area
wing is also being adjusted,
ng the bird to fly at something
e optimum lift/drag ratio what-
s speed at the time.

albatross is a splendid sail-
but no man-made sailplane
emulate the performance of the
floating above the stormy seas
it lives out its existence, and
ining, with very little muscu-
ort, its ceaseless food quest.

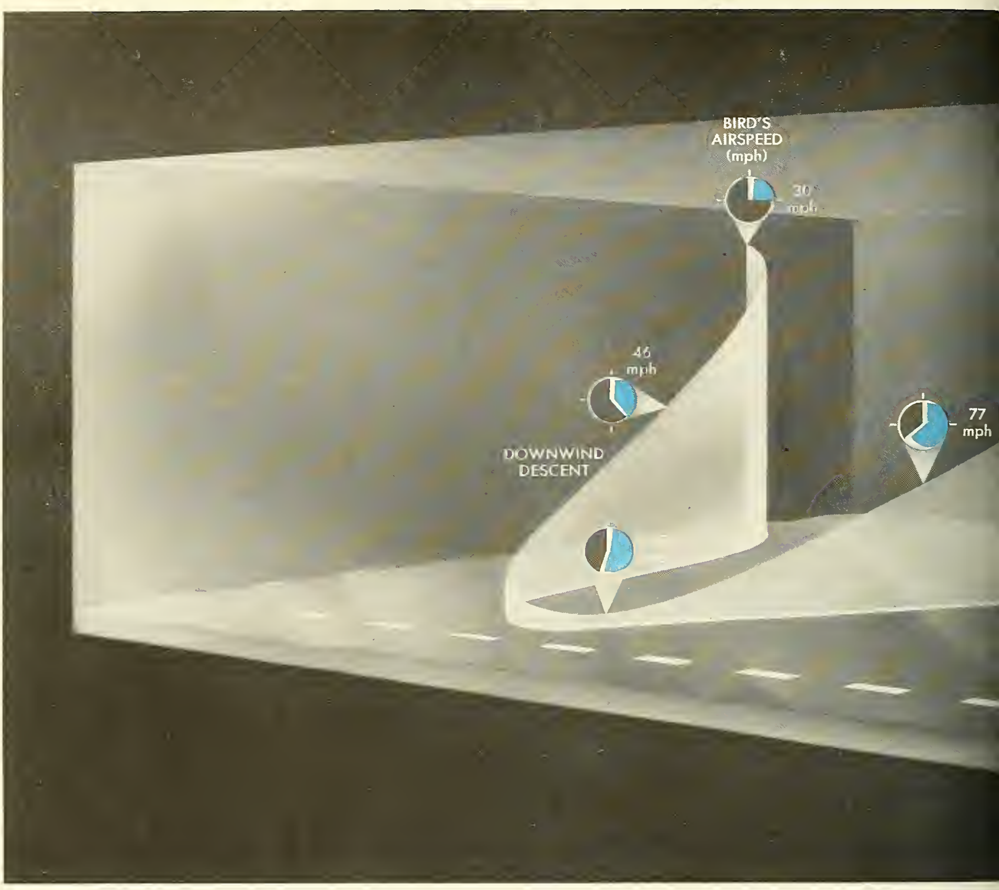
bird or any sailplane, gliding
h the air, is continually over-
g drag; dissipating energy
he store made available by the
's weight, height, and speed. To
at a constant or increasing
height must be sacrificed. That
say the glider must be going
hill" through the air current in which it moves. By seeking out places where this current is moving upward, the pilot maintains or gains height.

Such upward currents are found on the windward side of hills: in "thermals" where warm air, heated by the sun, is rising from the ground; and in "standing waves"—where air, passing over a range of hills, dips down on the lee side and rebounds in a series of waves. The first and last types of lift are available, in some degree, above the great waves of the ocean—upward-flowing air on the flanks of the waves when the wind is moving faster or slower than the swell, and rebounding air on the lee side of the crests. But such upcurrents are too irregular and operate too near the surface to give the bird the sustained lift it requires for continuous flight. The albatross flies as it does by exploiting the power of the wind in quite another way.

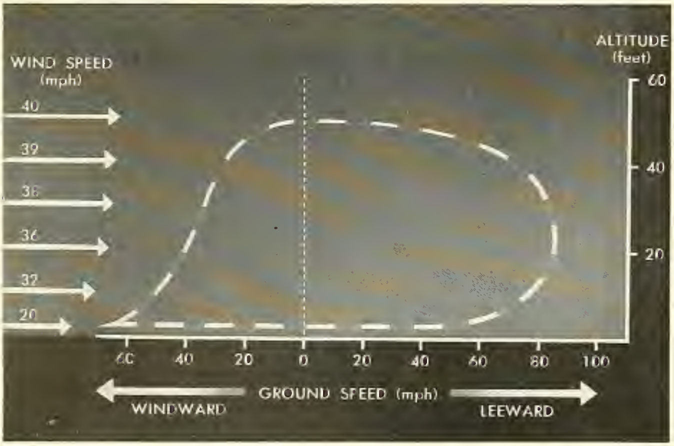
Wind blowing over the sea is slowed down by friction. If the speed of the wind is, say, forty miles per hour at fifty-five feet above the sea, it may be only twenty miles per hour close to the surface. If we measure the speed of the wind up to an altitude of fifty-five feet and if we plot wind speed against height, the result will look quite like the graph on p. 64. The bottom layer of air is held back by its friction with the water and, as we go upward, each succeeding layer is slowed by friction with the slower-moving air below.

A Wandering Albatross gliding *in still air* on outstretched wings, at fifty-five feet with an airspeed of thirty miles per hour, starts a dive toward the water—using the force of gravity to increase its speed—and levels out just above the surface, flying at about forty-eight miles per hour. It immediately starts to climb, converting back into height the extra energy it has gained in the dive. When it has risen to, say, forty-five feet, it will have used up this surplus energy. Its airspeed has now fallen away to thirty miles per hour, it has lost ten feet of height and must now start down again. The next upward swoop brings it only to, say, thirty-two or thirty-five feet; and so on, in gradually diminishing upward curves, until it must flap its wings or settle on the water. Evidently there is no future for our albatross in this type of effortless flight.

Take the same bird, gliding at thirty miles per hour airspeed, fifty-five feet up, *not* in still air, but before the wind. The wind is blowing over the sea at forty miles per hour at this height and at twenty miles per hour immediately above the surface. The albatross starts a dive exactly as before. *In still air*, it would reach an airspeed of forty-eight miles per hour at the surface, but now the bird is gliding downwind. As it dives, it enters layers of air that are moving ever more slowly over the water. In consequence, the airspeed of the bird builds up more rapidly and—by the time the albatross reaches the surface—it will be much greater than before. The albatross will have attained an airspeed of sixty-seven miles per hour when it levels off just above the sea. An albatross skimming along at an airspeed of sixty-seven miles per hour has a lot of surplus energy—more than enough to enable the bird to soar back to its original height of fifty-five feet before its airspeed again



Idealized flight path for a Wandering Albatross during moderate to strong winds is plotted here from the author's data. At start of downwind descent, *left*, bird has minim
airspeed of 30 mph: bird, with wind behind it, has built

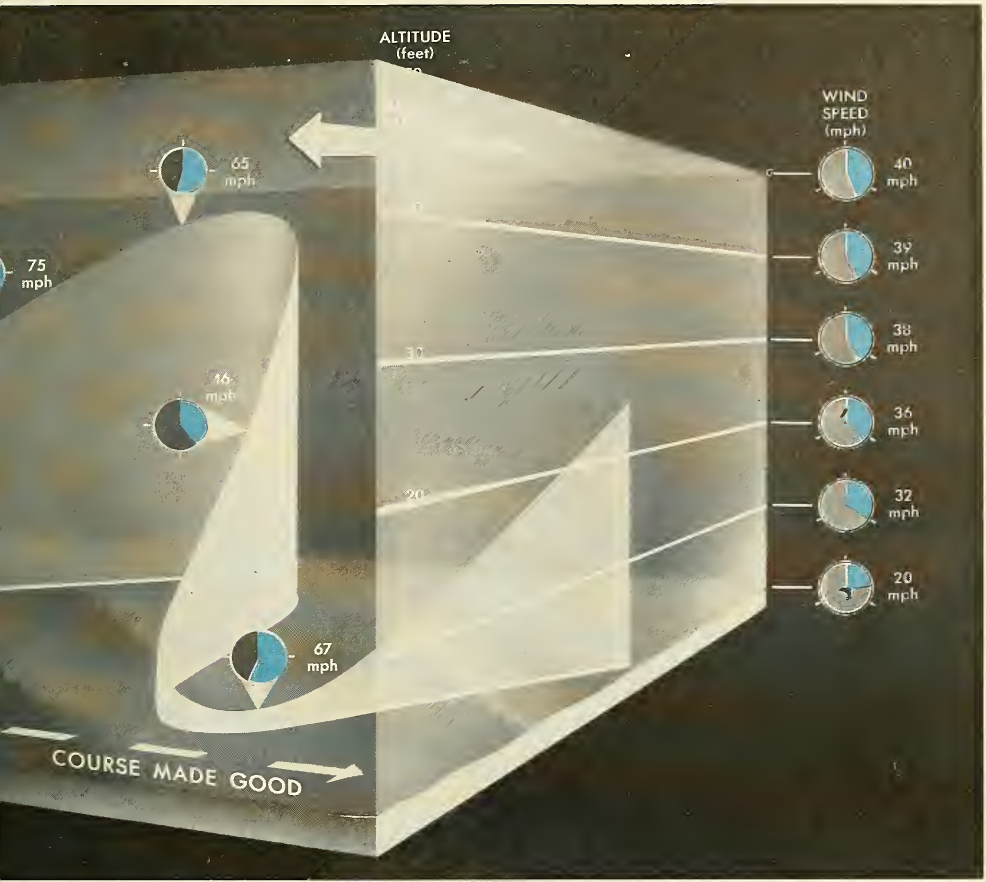


Ground speed, plotted against bird's altitude during flight circuit, *above,* shows bird's maximum speed over water to come during steep, leeward descent.

drops away to thirty miles per hou
provided it is in still air or clim
across the wind gradient.

This is a considerable improvem
on the first state of affairs. but s
not good enough for following a sh
For the bird, in the course of its di
has been moving downwind at ve
high *ground* speeds (up to eigh
seven miles per hour when airspe
and wind speed are added togethe
and it has made considerable
way, which must be regained.

Luckily, the albatross. when it
gins its upward swoop, is not in s
air, but has turned *into* the wi
which—as we have noted—is blowi
over the sea at varying speeds.
the bird rises. it is constantly enteri
faster-moving layers of air. At thi
feet. the albatross has an airspeed



eed to near 60 mph as it approaches surface and turns into wind. Long, upwind ascent now carries bird into increasingly fast wind layers, so that loss of airspeed is gradual. Finally, altitude regained, bird starts next dive.

seventy-five miles per hour: it
hes fifty-five feet not at thirty but
venty miles per hour. It has been
ing much faster over the ground
indward all the way up, is still
ing against the wind at the top of
climb and has regained all the
ay lost in the dive!

the reader is still with me, we can
ow go back to the Southern
n scene of three pages ago, ap-
g the data we have just related
e flight first described.
t the highest point of its flight
e the bird has an airspeed of
y miles per hour. It turns down-
l and dives toward the sea, main-
ing a steady angle of descent but
ing airspeed rapidly because of
successively slower-moving layers of air into which it flies. At twenty feet, its airspeed is forty-six miles per hour; the wind directly behind it is blowing at thirty-six miles per hour, giving a ground speed of eighty-two miles per hour to leeward. The bird now begins to turn across the wind, diving into a trough between the waves, and finishes its downward trajectory with an airspeed of sixty-seven miles per hour but moving to leeward at the same speed as the sea, twenty miles per hour.

The bird, using any upcurrents it finds on the flanks of the waves, flies for some distance along the trough, banks and turns rapidly into the wind, using the strong updraft near the crest of a wave to gain considerable height—an initial kickoff, as it were, of ten or fifteen feet. Its airspeed, instead of dropping, actually rises as, propelled by its own momentum, it suddenly meets the faster-moving wind, and it forges quite rapidly to windward as it begins its steady upward climb, moving continually into layers of higher wind speed. At twenty feet, its airspeed is still over seventy-seven miles per hour and its ground speed—to windward—forty-one miles per hour. At thirty feet, its airspeed is seventy-five to seventy-six miles per hour and it is still moving steadily to windward at about thirty-eight miles per hour. By keeping a fairly steady airspeed, the surplus energy accumulated in the dive is used to gain height. It finishes the upward climb with an airspeed of sixty-five to seventy miles per hour, still forging slightly to windward as it

Admiral Jameson's account of the albatross's soaring flight is taken from his new book, *The Wandering Albatross* (Morrow). Guy Tudor, whose work has appeared here before, did the accompanying bird paintings.

turns across the wind, and regains its position above the starboard quarter of the ship without having lost height or made any leeway.

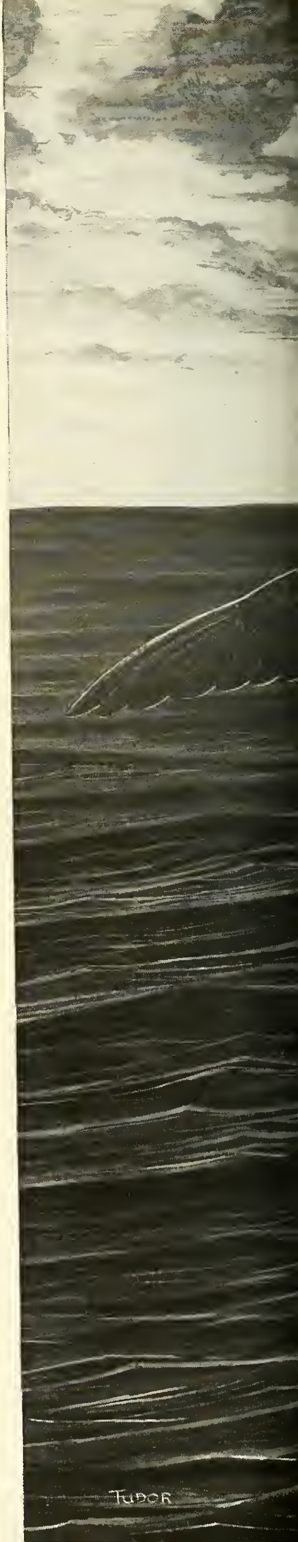
The cycle described is a typical one, susceptible to a very large number of variations, according to the strength of the wind, state and direction of the sea, mean course followed by the albatross in its search for food, and so on. The principle followed in all cases is the same, the bird making but incidental use of air currents near the waves—relying on the *variations* in wind speed for sustained flight.

Scientifically accurate data about the flight of any bird are almost impossible to collect. One cannot make a live bird fly in a wind tunnel, nor force it to follow a prepared track along which instruments have been set up. Records of the movements of birds in flight and of the surrounding air are susceptible to considerable error. The difficulties are greatly increased for sea birds, moving fast over great waves through air which, in its lower levels, is as turbulent as the stormy sea below.

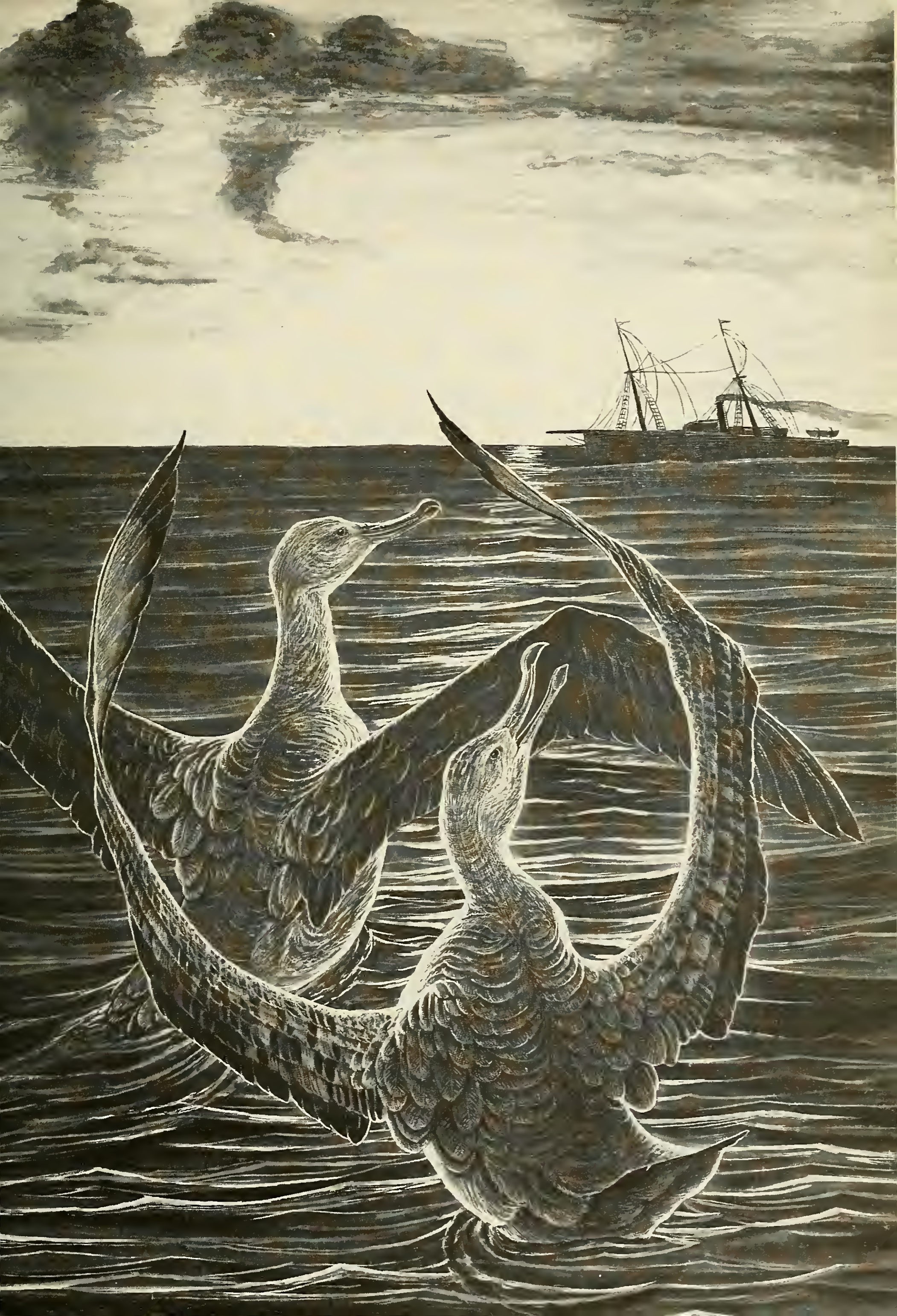
In the 1920's, a careful field study was carried out by Professor P. Idrac of the Ecole Polytechnique, in Paris, using both automatic cameras to take photographs every tenth of a second and smoke floats and anemometers to measure the direction and velocity of the wind. It was Professor Idrac who first established the now generally accepted theory of the albatross's flight, which I have endeavored to explain here. In his conclusions, given in a paper published in 1924, he stated:

> First: only birds that are aerodynamically very "clean" and that can fly at high airspeeds can keep aloft in this way. High speed is essential to build up plenty of kinetic energy in the downward dive. The energy accumulated varies with the square of the speed, that is, it is *four* times as much at sixty miles per hour as at thirty miles per hour.
>
> Second: albatrosses (and Idrac included the smaller albatrosses) usually fly at airspeeds varying between thirty-five and eighty-five feet per second, that is, thirty and six-tenths and fifty-seven and eight-tenths miles per hour. Their mean airspeed is about sixty feet per second, forty and eight-tenths miles per hour. They fly in a shallow layer of air, extending from sea level to about forty-five feet, although this maximum height is exceeded when the wind is giving greater differences between the "free" and surface winds and providing more assistance from eddies and updrafts close above the waves.
>
> Third: the complete flight cycle is often very regular, with an elapsed time, summit to summit, varying by as little as one second, proving that there is little dependence on the highly *irregular* air currents and eddies around the waves.
>
> Fourth: soaring flight without wing-beating is possible only if the *minimum* wind velocity at sea level is more than eighteen feet per second—that is, eleven and five-tenths miles per hour.
>
> Fifth: the trajectory of the bird is adjusted according to the strength of the wind and its direction relative to the mean course followed. When the wind at sea level reaches fifty feet per second (thirty-four miles per hour), the bird must make leeway, unless it can find an area of slower-moving air in which to fly; that is, in the eddies and updrafts close to a ship.

Mankind's own efforts at soaring flight in his most modern sailplanes, helped by the best instruments he can devise, seem clumsy when compared with the natural performance of this great bird. The Wandering Albatross's utilization of meteorology, aerodynamics, and applied mechanics is as marvelous as its split-second reactions to constantly changing conditions, particularly in the highly turbulent air around the waves. One of the greatest of glider pilots, Philip Wills, has admitted that a man-carrying sailplane, even with a wing span as low as thirty feet, would be far too cumbersome to operate in such a shallow layer of constantly varying air. It seems unlikely that man will ever be able to emulate the albatross, except within the confines of his imagination.



Long wings of the albatross, ideal for gliding, are embarrassment when bird must leave water during times of calm.



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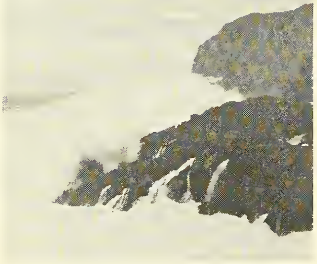

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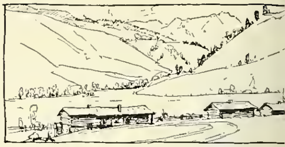

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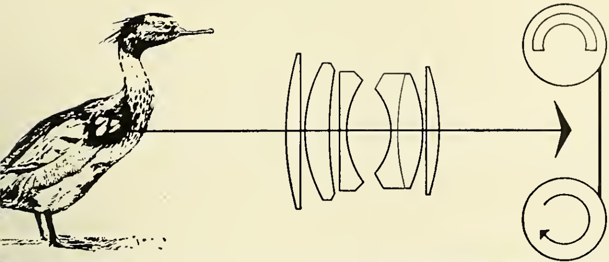

ATURE AND THE CAMERA

By DAVID LINTON

T is the most important thing to ve in order to take good pic- s it a fine camera with fast lenses ensive lighting apparatus? Ap- / not, because we have seen many :tures taken with the simplest ent (witness Arnold Genthe's e of the San Francisco fire, done borrowed box camera). Would it rough understanding of the fun- als of photographic technique? most of the good pictures we see us wouldn't exist.

think the first requirement is *an* e—the ability to *see* pictures—to ch them without preconceived how they should look or of what sible" or "impossible" to photo- I think we should be less con- with the wide aperture of the lens re concerned with the wide-open ind it.

chief reason for learning photo- technique is to be freed from it p it out of the way so we can rate on what we see. In fact, ig- of technique is sometimes a . We have all seen exciting pic- ade by beginning photographers ln't know that what they wanted as "impossible," and who there- cceeded in doing it. While this disconcerting to the experienced aphers, it is undeniable.

of the most lively pictures ever vere made in the very early years tography, using techniques and ent that would make us turn n today. Why did the mid-nine- century photographers, like Julia et Cameron and David Octavius d their contemporaries, produce remarkably high proportion of ctures? One explanation that has een advanced is that most of them training before they took up pho- hy. This explanation, however, help much—we find lots of pho- ers with art training today and just the same as the rest of us. s also been suggested that the fficulty of the new medium made the early photographers work harder. That is certainly true. After William Henry Jackson scrambled up a mountain in the 1870's with his 20x24-inch camera, a wooden case of glass plates, a stove, chemicals, and a portable darkroom tent; when he set all this up on some wind-swept pinnacle, heated and mixed the emulsion and coated the plates with it, then rushed the wet plate to the camera in a light-tight box, he surely was not inclined to take photography lightly.

But whether this explains the results Jackson got is another question, and a moot one. We do not find that pictures taken now with great difficulty are noticeably better than those that are easy to take. If anything, they are worse.

I think there must be another reason. The early photographers did not have their memories cluttered with pictures. The "rules" had yet to be invented, and nobody knew what was impossible. Of course, they had studied paintings and drawings, but the quantity was negligible compared to the deluge of pictures that engulfs us today. Thus their minds and eyes were open. They didn't have ready-made ideas of what a picture should look like, and they didn't know what was technically possible and impossible. But they wanted to find out, and that challenge helped them produce pictures still memorable, after 120 years.

Today, very little is really "impossible" to photograph. The tools have developed far beyond our ability to think up ways of using them. It is now possible to photograph anything that can be seen, and a lot that can't. But technical progress has not found us ready with corresponding progress in our thinking about what a picture should be. Instead of opening up ways of doing new things, the vastly improved tools have often simply done the same old things less well. In just the same way, the invention of the flash bulb ushered in a twenty-year period of stagnation in newspaper photography. Taking pictures became so easy that a chimpanzee could learn to do it, and there was no effective challenge to the press photographers' thinking. Fortunately, the dark ages are past in that branch of the field, and the creative intel-

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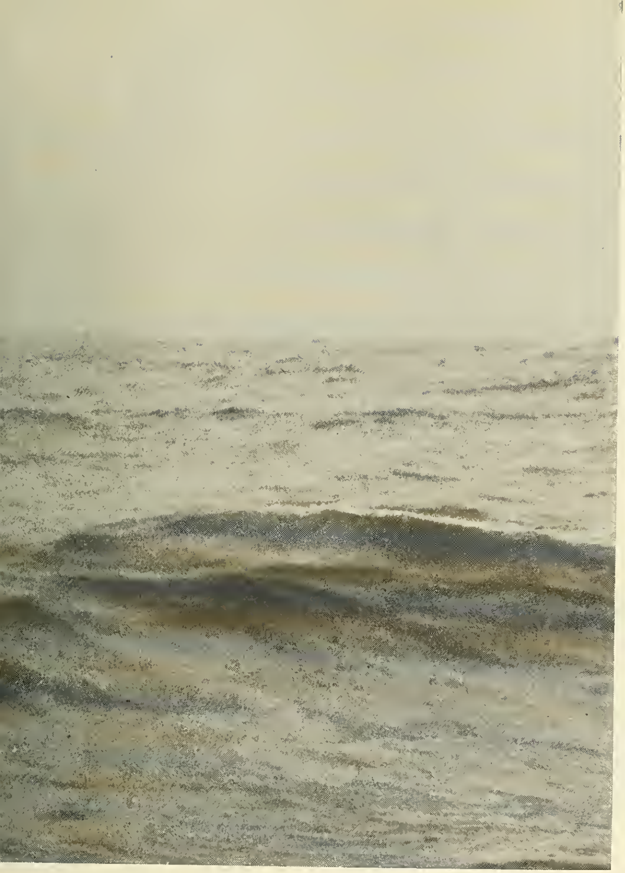
Perfect weather is not necessarily a requisite for fine pictures. The eye behind the lens can often take advantage of unusual situations to produce dramatic photographs. fog pictures on these pages are examples of a "seeing



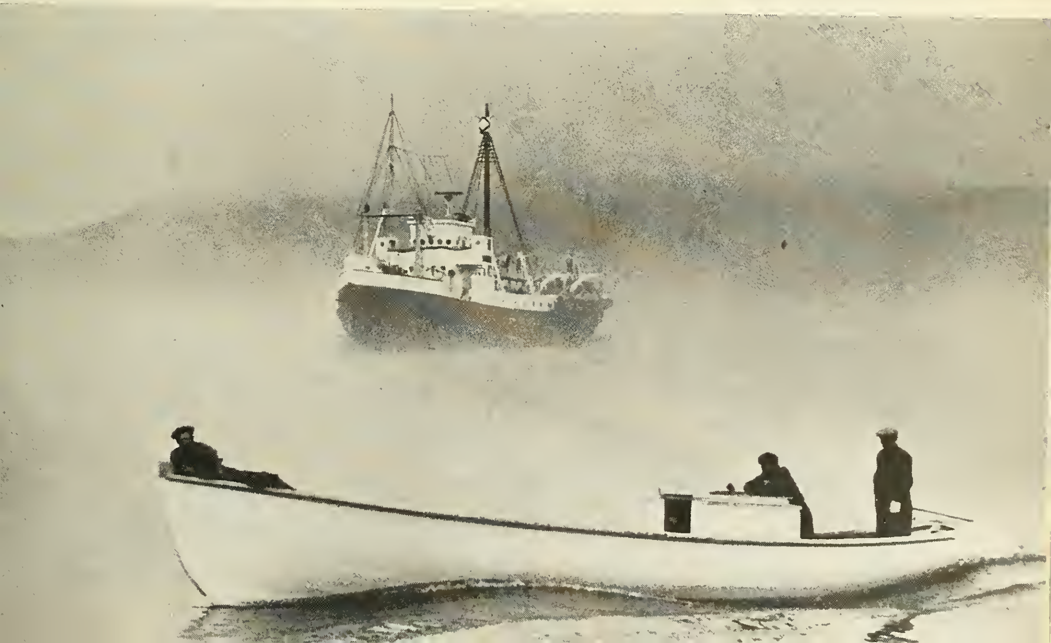
David Linton's by-line has appeared under photographs in all the nation's leading magazines. His camera column will be run regularly on these pages.

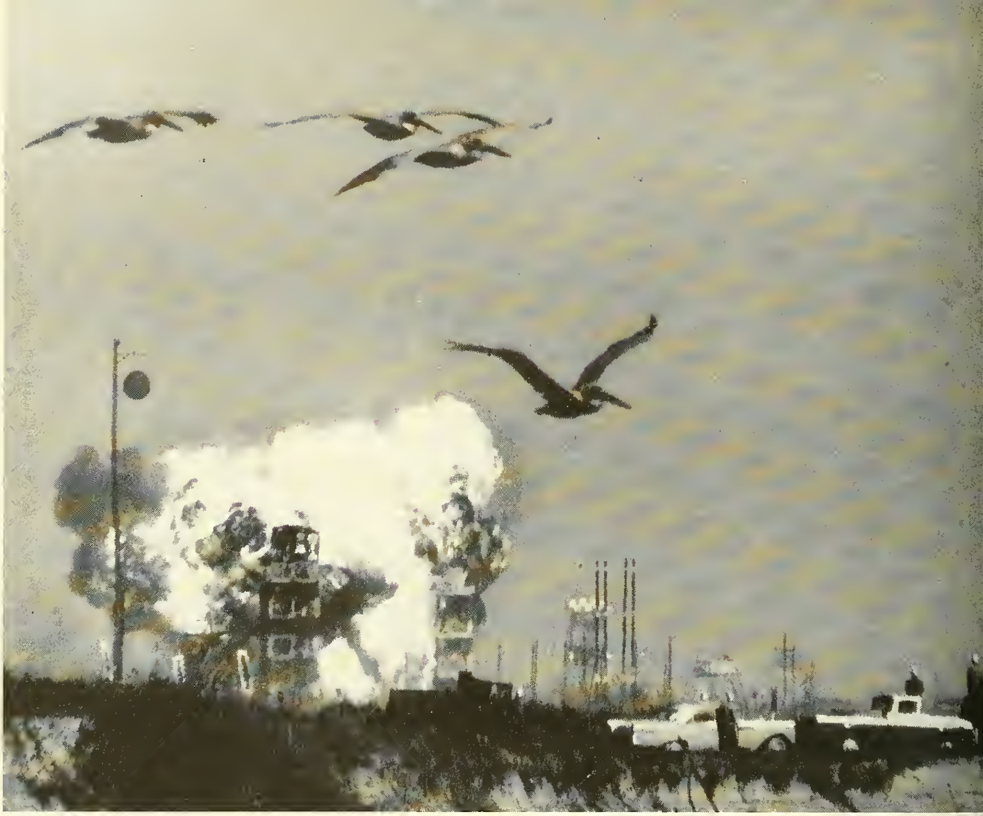
ligence of newspaper photographers is now channeled toward the *content* of pictures rather than ways to take them.

Photography is something like Antaeus, the giant with whom Hercules wrestled. He was invincible as long as he touched his mother, Earth, and Hercules fought a losing battle until he lifted Antaeus off his feet. So photography must touch home base—the real world—to keep its strength. No photographer, no matter how brilliant, can create better pictures than nature invents. Our problem is to find these natural inventions, isolate them, and fit them into the small compass of what we call a picture.

The biggest obstacle in this endeavor is the preconceived idea. No two events in nature are ever exactly alike, just as no two snowflakes are alike. But all of us have seen so many pictures that, when we go to photograph something, we are likely to start out with an already formed idea of what it should look like. When we get there, and find it does not look like our mind's-eye view, we may be disappointed and miss the real picture.

Planning a picture in advance is good, but not when it replaces seeing. The picture of the two fishermen in a dory is an example. It was part of a picture story on a Newfoundland fisherman and his family. One picture of fishing was ab-





solutely essential to the story. But most of the time I was at the fishermen's remote village, the weather was so bad that the boats stayed on shore. On the one day that looked promising, I got up before dawn and went out with two boatloads of fishermen. The fog was so heavy they could not find the fishing grounds. Rain drenched my cameras, and I was frightfully seasick. After catching nothing for a couple of hours, the fishermen turned back. I had only a few pictures, and was sure that the story was ruined. But one picture later became one of my favorites, told the story better than a well-lighted shot with the boat full of fish.

The other two pictures seen here have something in common beyond the fog. Both were totally unexpected—they were scenes that suddenly presented themselves in front of my lens—and both were taken under light and weather conditions that were seemingly prohibitive.

EVERY photographer has had the unsettling experience of finding relevant, important elements in his pictures that he did not notice when he took them. I say "finding," because there is no doubt that they were seen, but the photographer's reaction was so quick and instinctive that the conscious mind never got into the act. These "accidents" are not accidental at all; they are simply another indication of the vast, often untapped, resources of the human mind. They are of the same stuff as the sudden, original insights that are so often crucial in scientific discovery; the unconscious synthesis of years of training, study, and practice.

One of the most memorable pictures of the Vanguard rocket that blew up on its pad was taken by Burt Glinn. In the foreground, forming a perfect frame for the conflagration, are four pelicans, obviously frightened into flight by the noise of their flightless neighbor. As Glinn tells the story, he shipped his film off to the laboratory and waited nervously for the report. The next day he got it by phone: "The picture is good and the birds are just wonderful." His answer was, "What birds?" (See photograph above.)

This has happened to me perhaps a dozen times. Not long ago, I was photographing a busy street from a second floor window. As I squeezed the shutter, a curious and quite irrelevant thought entered my mind. I remembered a story I had heard a couple of years back. It concerned a man who went to the opening of a Broadway play. During the first act he noticed that the seat next to him was occupied by a dog, who sat up and watched the action on the stage great interest. At the end of the ac dog applauded vigorously. As the l lights came on, the man turned t dog's human companion and sai don't understand. He seems to be fo ing the play and enjoying every m of it. Is that possible?"

"I don't get it either," said the panion. "He didn't like the book at

I was completely at a loss to u stand why this story came so force to mind while I was photographing street. But later, when I examined a largement of the picture, I found th swer. Someone had left a dog in o the parked cars on the other side c street. The dog, sitting in the dr seat with its paws on the steering w seemed to be about to drive away.

There is probably a certain u scious element in every good pic There has to be, because there a many facets to most pictures tha conscious mind could hardly encom them all at the moment of exposure they all fall into a perfect relatio so frequently that it cannot be acc tal. The open mind—the open eye respond to them and organize them a picture. The mind limited by pre ceived images cannot.

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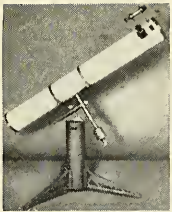

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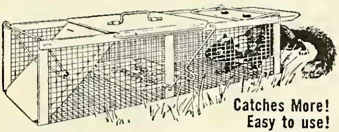

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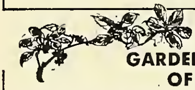

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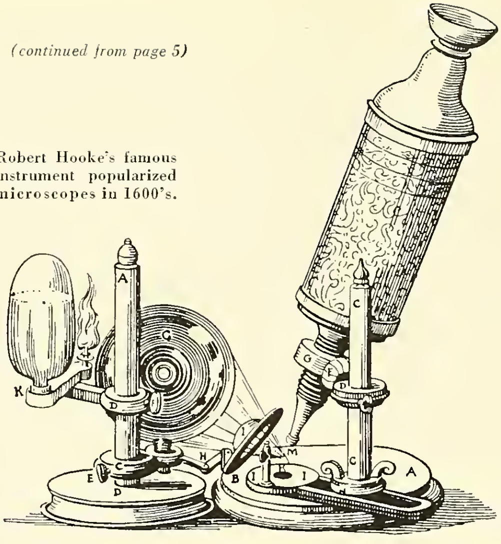

Robert Hooke's famous instrument popularized microscopes in 1600's.

tific renaissance. Other essays in the volume deal with magic, herbals, and Europe's earliest "university"—the medical school of Salerno, which flourished in the eleventh and twelfth centuries.

Also under the title of *A Short History of Science* (Doubleday Anchor, 95¢), Jean Lindsay has collected a symposium of twenty-six articles by British authorities. Originally a series of broadcast talks, they inevitably seem short and pat between covers. For example, Sir Lawrence Bragg on "The Atom": "I cannot enter here into all the discoveries which have made the atom seem so real to us, but I may perhaps describe a few of them which I always regard as exciting ways of reaching out towards an idea of these tiny things which are so much smaller than anything we can . . . see."

ANOTHER praiseworthy but unsatisfactory work is William C. Dampier and Margaret Dampier's *Readings in the Literature of Science* (Harper Torchbooks, $1.50). The scheme here is a total of forty extracts ". . . taken to illustrate the development of definite subjects in the thought of succeeding ages . . . ." the subjects being cosmogony, atomic theories, and evolution. The snippets are perfectly good snippets but they scarcely represent the broad fabric from which they were cut—nor do they represent adequately the true abilities of Sir William Dampier, author of the excellent *A History of Science and Its Relations with Philosophy and Religion*, one of the more distinguished one-volume histories.

In the same publisher's series, *Science Since 1500* by H. T. Pledge (Harper Torchbooks, $1.85), is a tightly crammed, sometimes almost telegraphic summary of mathematics, physics, chemistry, and biology from its title date to 1939. Because of its very compression, it is perhaps not a book for a reader without any scientific background: on the other hand, it is particularly illuminating in its insights as to the relationships between the sciences, and provocative in its suggestion that there is an alternation between emphasis on discreteness and on continuity in the development of all the sciences during this period. In a preface written for the current edition (the original appeared in 1939), the author echoes Snow—"Science has been
divorced by culture . . ."—but goes
say ". . . not only does the intelle
and aesthetic value of pure scienc
main, but *that of applied science*
sibly exceeds it. What could be
aesthetic than zone melting, lite
wiping the impurities out of a b
metal, pushing them ahead with a
ing coil? Subtlety is indeed the
essence of the critical conditions
cases at the limit of the possible,
which the technologist is so const
concerned." The sheer beauty inh
in many scientific processes could,
ploited, open another breach in the
between the cultures.

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cal subject and its author is Sar
successor in the chair of science hi
at Harvard. This book is one of a s
initiated by the Physical Science S
Committee to improve the teachin
these sciences in secondary school
it, the author describes how the
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treatment were discovered by Co
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result of the revolution in astron
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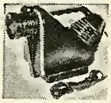

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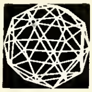

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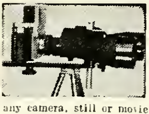

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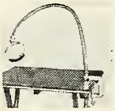

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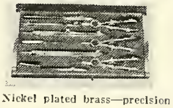

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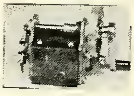

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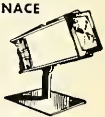

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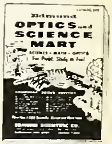

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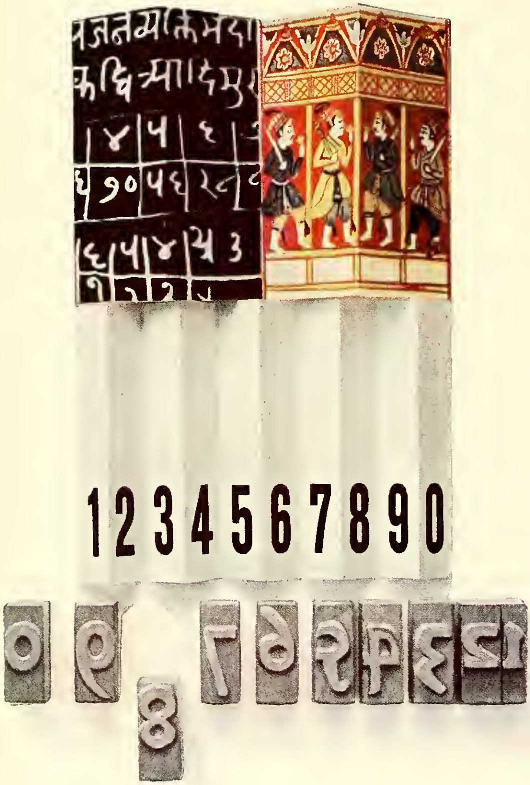

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COVER: This male catkin of the large pussy willow, *Salix discolo*
composed of hundreds of minute flowers that lack petals or sepals. The
yellowish knobs are anthers, each filled with thousands of pollen grains
the pollen is shed, the catkins wither and fall from the tree. This is just
of the hundreds of varieties of modest blossoms that announce to the ca
observer that spring has, indeed, arrived. These relatively ephemeral
flowers present as fascinating an array of color and form as do the p
pushing up through the ground. To learn more about them, turn to pa

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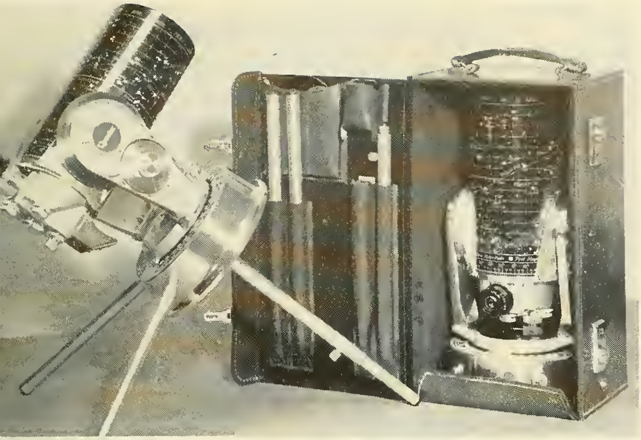

flying squirrel is a charming visitor hardly larger than a mouse. Photographed by a star owner from 30 ft. Reduced to actual size from grainless 8x10 prints. Note detail.

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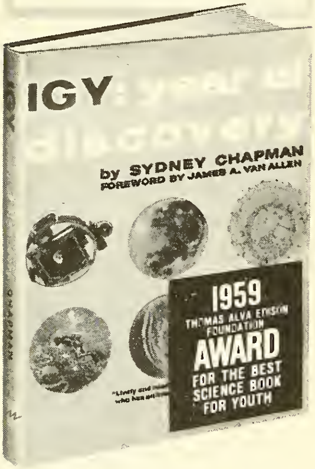
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Review

A masterly study of life in the ocea

Reviewed by NORMAN J. BER

THE OPEN SEA: Vol. I, The World of Plankton; *$6.50; 335 pp.* Vol. II, Fish and Fisheries; *$7.50; 322 pp.*, by Sir Alister Hardy, *Houghton Mifflin.*

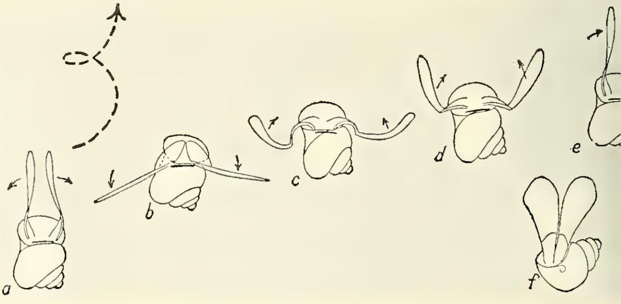
THE OPEN SEA has caught the fancy of sailors and naturalists for ages past, and Alister Hardy—although he is a scientist, concerned with marine biology in general and fisheries in particular—is one with the rest. These two books, especially the first, are written with the enthusiasm that a genuine naturalist is bound to feel about the life of the ocean.

Awareness of the ocean's beauty was perhaps commoner in the days of sail than it is now—the seas today are increasingly flown over or crossed by engined ships so fast that no one has the chance to see beneath the surface. Today, few but the professional biologist or oceanographer is likely to get a close view of the sea's living form and activity in all its astonishing variety. Who else now knows at firsthand the nautilus of the ancient Greeks or the by-the-wind sailor of early English seamen? Drake's chaplain on board the *Golden Hind* wrote, enchanted, of the fry of flying fish scudding like bees over the calm equatorial Atlantic. Another Elizabethan mariner, Richard Hawkins—waiting off the Azores to intercept the Spanish fleet—beguiled his time by hauling buckets of water to the deck and watching with fascination the "corruption" they contained. A marine biologist of today would give his eyeteeth for a similar opportunity.

It was not until early in the nineteenth century that naturalists were well enough informed to take an intelligent interest in the creatures that drifted with the ocean currents. It was during this period that the tow-net was invented as a r
of capturing the smaller or near
visible kinds. Vaughan Thompso
amateur naturalist serving as an
surgeon in Ireland, was the first t
a net to collect plankton: on the *B*
five years later, young Charles D
". . . often towed astern a net of bu
and thus caught many curious anin
But it was the German naturalis
hannes Müller whose use of the to
beginning in 1844, established it a
principal instrument for explorin
in the seas, other than that of th
floor or of fish and other large for

Refinements in tow-netting hav
creased from Müller's day to this.
nets of graded texture or nets des
to operate and close at different d
becoming widely employed, as the a
sis of planktonic life progressed fro
purely qualitative to the quantitati
became customary to haul nets a
tions plotted along a course, as a r
of sampling the state of the pla
across a given sea, or at a sequen
depths from the surface. Such p
dures have been invaluable, thoug
their nature they have been some
spotty. Hardy's own great contrib
to plankton investigation is the con
ous plankton recorder, now known a
Hardy plankton recorder, which wa
vised on the *Discovery* Antarctic ex
tion of 1925-27. Since then, this ap
tus has been employed everywhe
make continuous samplings of plan
ic life for hundreds of miles at a

Life in the sea is remarkably
both in variety and quantity; and t
especially true in the uppermost la
which absorb most of the sunlight
trating the surface. Acre for acre, o

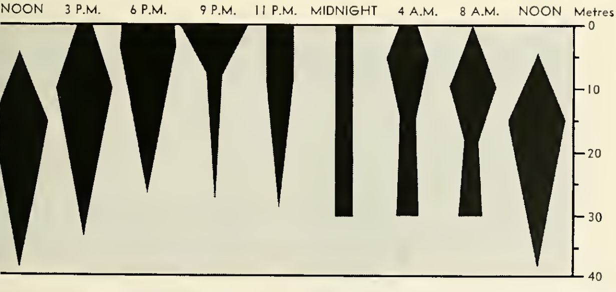


e. the sea is about as productive as
id: and whether plankton comes
sed directly as food or whether we
ie to eat only the fish and whales
orts at the top of the food pyra-
ie over-all productivity of the sea
reat that we will necessarily turn
ore and more. For, since oceans
hree-quarters of the globe, by far
ater part of the life of our planet
found in them. Indeed, we must
hem regionally, the more so since
per, planktonic zone, where life
dense, the mid-ocean depths, and
floor each requires different tech-
of examination.

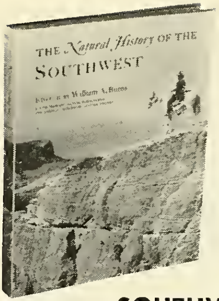
ardy's two volumes, the first deals
ie planktonic life in general, to-
with life in the depths (except
), and the second is concerned
with fish and fisheries. The ma-
fe of the seashore and inshore
is not included—for this the
must turn to *The Seashore*, by
Yonge, published in the same se-
d, like *The Open Sea*, illustrated
P. Wilson's superb photographs.
World of Plankton" begins by
ing the microscopic forms of
nd animal life, as numerous as
e small, to be found in the upper-
ne. These are the pasture types,
hich depends the existence of all
ger creatures visible to the naked
ese include the jellyfish—from the
orms, liberated by hydroids at-
to the sea floor, to colorful and
ular giants like the complex si-
hores. But it is the planktonic
ea, especially the minute cope-
nd the more shrimplike euphau-
at serve as the main link between
copic plants and the larger forms
ial life, for they are the principal
. Most of the basic green food
of the oceans, which is ultimately
ed into animal tissue, is proc-
y these small crustaceans of the
oceanic layer, and by the numer-
val forms of other creatures that,
nature, will live on the sea floor.
imarily a matter of relative size:
ch as these—small youthful stages
ll adults—can collect and feed upon the diatoms and flagellates that take the place of the vegetation of the land. Hardy's delicate water colors, along with Wilson's photographs, illustrate this section especially well.

The last part of this first volume is concerned with some of the more puzzling aspects of marine biology, among them the vertical migration of plankton. Migration of the plankton toward the sea's surface during dusk and dark, and down from the surface during dawn and daylight, has been shown everywhere to be a general phenomenon affecting all the plankton's components. The intensity of the light, and its effect on responses to gravity, appear to be involved, although the essential explanation of why such migration occurs still remains a mystery. For the phytoplankton—the microscopic plant life upon which the zooplankton feeds directly or indirectly—remains in the uppermost layer, and the migration is a phenomenon of the animal life alone. It is possible that, in changing location relative to the surface grazing layer, the planktonic animals utilize currents at different levels. Or perhaps the explanation is to be found in the so-called animal exclusion hypothesis, proposed a good many years ago by Hardy himself. This theory, based on observations that dense phytoplankton rarely contains much animal plankton and vice versa, suggests that the phytoplankton has some antibiotic principle that permits only brief excursions into it by animal forms. The whole problem remains wide open for investigation.

Life in the depths is only remotely and indirectly dependent upon events near the surface, and the section of "The World of Plankton" dealing with it is perhaps the most intriguing of the whole book: the inhabitants of this region are strange, and the problems they pose are not less puzzling. Vertical migrations are found once again, but now several thousand feet from the surface; while the nature of the relatively dense stratum called the deep-scattering layer is as unknown as when it was first discovered by echo-sounding. Bathyscopes have passed through it without recognizing it, yet



AL MIGRATION of plankton is shown, in diagram of the distribution of a copepod. At far left are "wing" positions of a pteropod rising (a–e) and sinking (f).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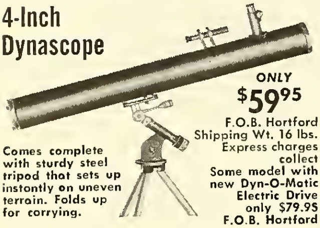

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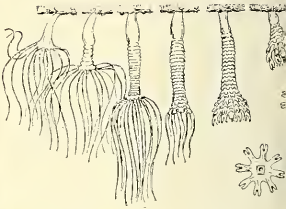
something that rises and falls with e turn of the earth calls for an expla tion. Hardy discusses the questio length, but leaves it unanswered. H also much concerned with the probl posed by the presence and operatio light-producing organs of the deep prawns, squid, and fish. He records, example, a recent report—that switc on a ship's radar stimulates phospho cence in the sea—as another fact to c on, not as the solution to a puzzle!



MEDUSAE budding from *Aurelia*, in Ha

THE SECOND volume, "Fish and Fis ies," is both an extension and a d opment of the first, successively ta up the pelagic fish with particular phasis on the herring, then the lif the ocean floor, and finally the g assortment of bottom-living fish that mainly upon the invertebrate bo fauna. In many ways, all this is familiar: we are dealing directly our own sources of food and comme profit. This is the economy of the with a human bias, where the fisherm interests seem more important than t of the biologist.

The two volumes make a fascina and instructive contrast in other w too, for the plankton and the bo fauna represent the two extreme oceanic life: the one forever conten with the force of gravity but li amidst the primary source of food; other supported by the sea floor necessarily dependent upon secon sources of nourishment. In both c by far the greatest supply of food the form of minute particles, li microscopic organisms in the cas the plankton and dead, particulate ter down below. The sea floor ani however, have two opportunities fo taining this material. They can filt from the water while it is still in sus sion (which is the habit of bivalves, colous worms, ascidians, corals, many lesser forms). These are the feeders. The other method is that o deposit feeders, which burrow into soft upper layer of the sea floor i swallowing large quantities of san mud for the sake of the digestibl ganic matter it contains. Both kin feeders are preyed upon by other tures—such as gastropods, starfish

BERRILL is professor of zoology McGill University, in Montreal. ong his numerous books are *Man's erging Mind* and *The Living Tide*.

—and these, in turn, together with filter- and deposit-feeders as are sible, are preyed upon by the bot- eeding fishes.

the same time, most of these ben- : echinoderms, mollusks, and crus- ns were seen in "The World of :ton" as larvae or as such relatively 'ed forms as the copepods. Ecolo- y, economically, and in terms of the ycles of individual organisms, the nain faunal regions of the sea are lementary.

' the second book is not exclusively n account of the bottom fauna. ludes fish living at all levels; and, :t, the first section of this volume tutes an excellent general introduc-) fish in the less deep, pelagic zone, asizing the herring in particular lso considering such diverse forms ia, mackerel, sunfish, and the pela- iarks. These are all described in on to their means of feeding, and is some discussion of their prob- of reproduction.

: pelagic fish are, in the main, built peed, and have blue-white coun- .ding or an over-all grayness that rs a degree of invisibility. On the n, however, the colors are predomi- / browns, yellows, and drab greens, ly mottled—also an effective camou- And the body shape of the most ighly adapted bottom fish is flat, ame form being very differently ·ucted in the cartilaginous and fish, respectively. Skates and rays 'ell treated in the book; but the flat fish, of so much greater im- nce as food fishes, naturally hold tage. The European flounder, in :ular, is fully discussed, both in and, through its breeding migra- in the North Sea, in connection fisheries generally. This account illy leads Hardy to a discussion of g methods and the over-fishing em, although here he is rather brief. ly, since the two volumes of *The Sea* are intended to encompass all of life in the sea, he considers s, porpoises, and sea turtles.

ese books are outstanding: enthu- :, detailed, personal, and incisive. udents of biology, whether inclined d the sea or not, should be required id both volumes of *The Open Sea*. would be better biologists for hav- ead them, and might even take an · hand in consequence. In any case, and any other reader would better ·ciate not only the fundamental lependence of life in the world's s but some of its beauty as well.

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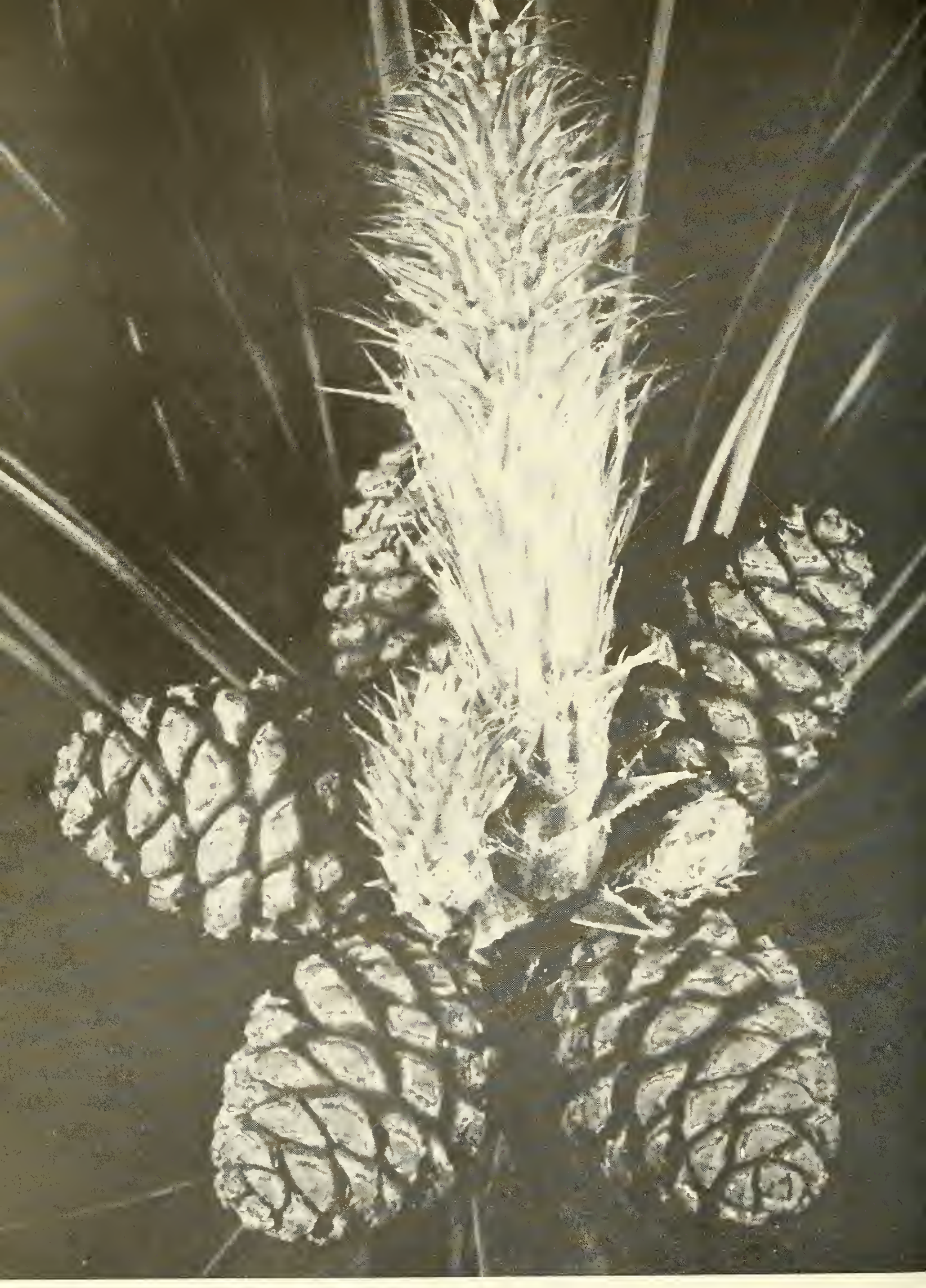


AUSTRIAN PINE "FLOWERS" are better known as cones. Here "candles" burst above year-old cones that were fertilized the previous spring and will mature in another year. same tree produces flowers of each sex on separate tw

Spring in the Forest

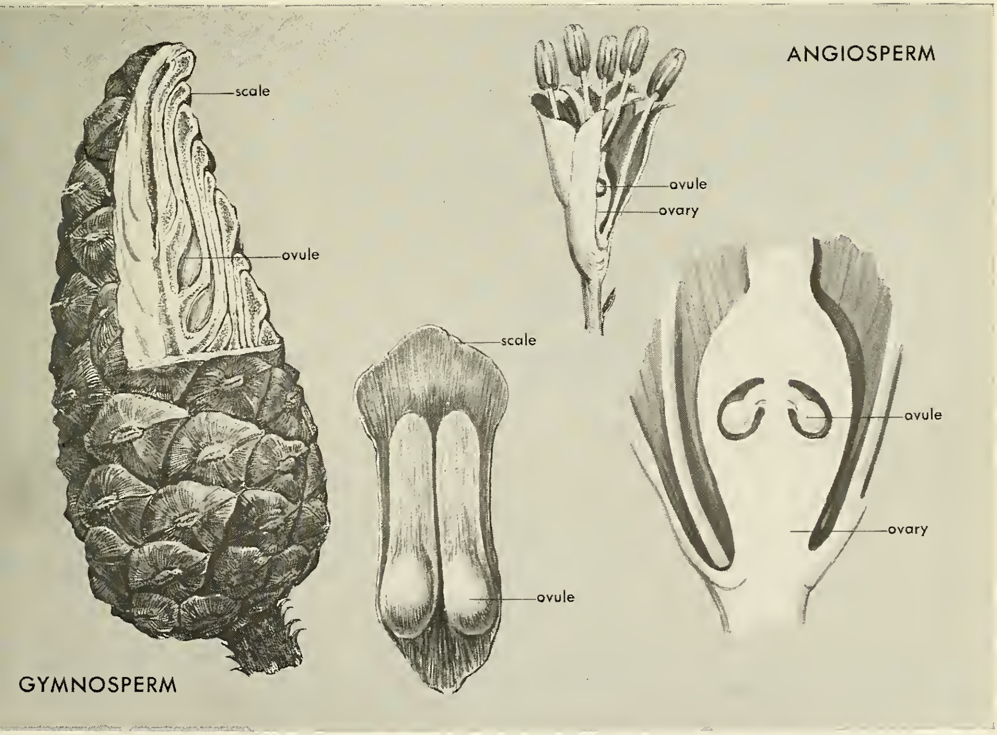
vanescent tree flowers present dozens of reproduction patterns

By John W. Andresen

THE WOODLANDS of the eastern United States, the death of winter nnounced by spring beauties, dog's-th-violets, bloodroot, and wild gin- emerging from the forest floor. At same time, warming temperatures l lengthening days stimulate growth l swelling within the flower buds of entire forest canopy.

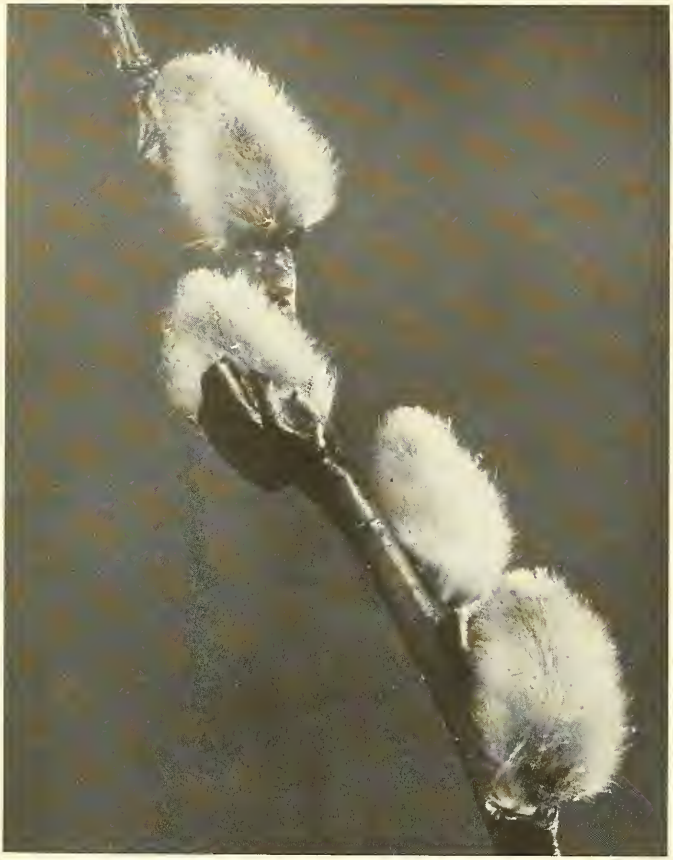
The flowers of many forest trees are ute, simple, devoid of bright col- , and relatively ephemeral. They erge, shed their pollen, and begin it formation all within a few days. discussing these varied blossoms, it is simplest to adopt the policy of botanists and separate them into two basic groups—those that bear petals and those that do not. Petal-bearing flowers can be divided into those in which the petals are separate and those in which they are fused together. Petalless flowers, in turn, can be divided into those forming aments or catkins and those that do not. Because petalless flowers are more simple in construction, we will consider them first.

Pines, firs, and spruces, as well as other coniferous trees, bear "flowers" —reproductive structures, variously known as strobili, cones, conelets, aments, or catkins. They are unisexual; they lack petals; and they are remarkably uniform in shape throughout the various genera. The names of the two large subdivisions of higher plants, Gymnospermae and Angiospermae, help explain this major difference. Female "flowers" of gymnosperms (including the conifers, the ginkgo, and the cycads) lack an ovary —the protective wall that, in the angiosperms, surrounds the ovules and later develops into part of the fruit. Instead, gymnospermous ovules are



MNOSPERM "flower" is unisexual and apetalous. Ovules borne on inner surface of scales that make up the cone.

Angiosperm flower has an ovary—a structure that protects the ovules and later develops into a part of tree's fruit.



Pussy willow's female flower cluster is composed of dozens of vase-shaped pistils, each with ovary, style, and a stigmatic surface where pollen lodges.

borne on the inside of a scale: the term "gymnosperm" means naked seed. In contrast, the angiospermous ovule is enclosed in an ovary—a structure composed of one or more carpels—that covers and protects it: the term "angiosperm," means seed vessel.

In pines, clusters of male or female flowers are usually separate and are found on different branches. Even though the genus *Pinus* and related genera usually bear both sexes on one tree, cross-pollination with other trees is essential for a high yield of fertile seed. If the female flower is pollinated by a male of the same tree, the seed of the mature cone will usually be sterile.

In early May, the crimson-colored female conelets of pine are borne at the tip of the elongated shoots or candles. Each conelet, only about a quarter of an inch long, may consist of as many as forty to fifty individual ovuliferous scales—arranged in a tight, compact spiral about the conelet axis. The fleshy scales are upright and slightly spread before pollination, but after pollen grains reach the ovule, the cone scales close tightly, gradually become more woody, and the conelet begins to assume a pendant position.

In hard pines, such as the red, pitch, and the Virginia pines, male flower clusters, or aments—which look like miniature ears of corn—are formed within buds by autumn. The soft pines differ: the spherical aments do not form until spring. After the male flowers shed their pollen, they wither, dry, and drop from the tree.

The cones of most pines require two years to mature. During the first year, a tubelike outgrowth from the pollen
grain pushes through the outer ov
tissues until it contacts the egg cell a
effects fertilization; in the second ye
the cone and the seeds it contains
large and mature. Spruces, hemloc
firs, and yews, in contrast, requ
only one growing season to reach th
full maturity.

DR. ANDRESEN, a research associate i
vegetation studies at THE AMERICA
MUSEUM, was formerly at Rutgers an
is now an instructor in the Departmen
of Forestry, Michigan State Universit

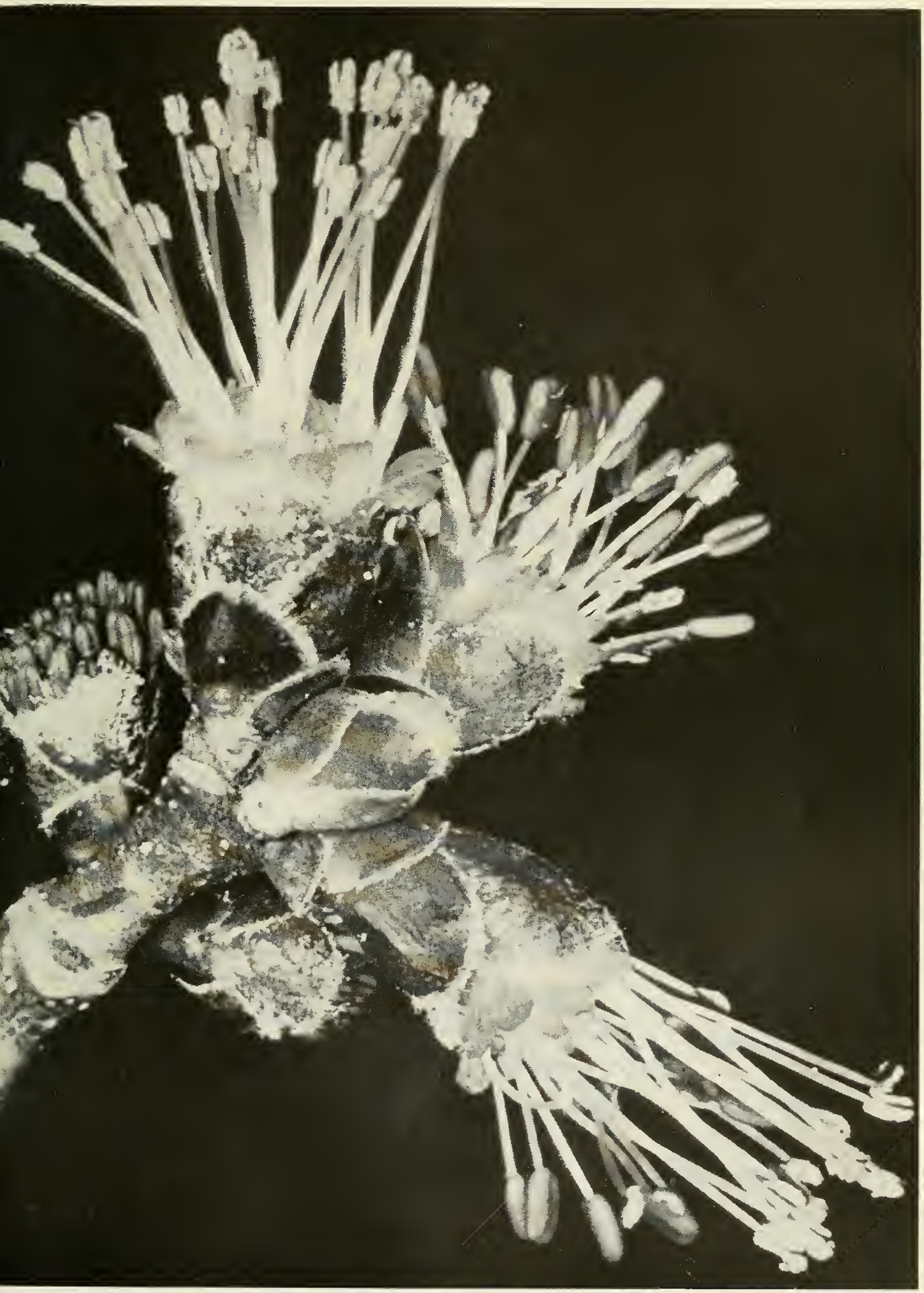
On rare occasions, individual con
erous trees will bear flower clust
that contain both sexes. Records
this abnormality in the spruces in
cate that these hermaphroditic str
tures are functional; that is, they b
viable pollen and receptive ovules. Y
the conelets from these trees seld
mature into seed-bearing cones.

SEXUAL maturity in the conifers v
ies between species, but some p
cocious individuals of black spru
northern white cedar, and many d
ferent pines have flowered at five ye
of age. Pitch pines growing in N
Jersey have produced flowers wh
only two years old, and there is a r
ord of a Chinese pine bearing m
aments when only one year old.

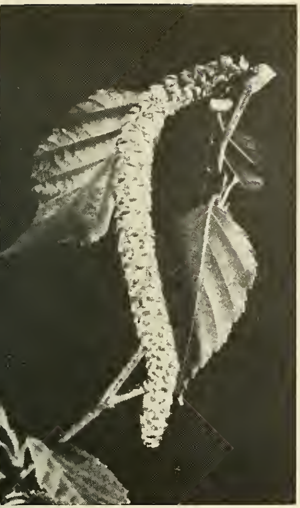
Among angiospermous trees, al
many examples of unisexual flow
may be found. Indeed, most botani
recognize that trees and shrubs be
ing simple unisexual, catkin-like cl
ters of flowers are primitive memb
of the angiosperm subdivision. T
ament or catkin that typifies this gro
is really a compound flower or infl
escence of up to a hundred individu
but very simple flowers, which la
petals or sepals. Each ament contai
flowers of one sex.

All of the willows, aspens, popla
and cottonwoods, and many of t
sweet gales bear either male or fem
flowers on separate trees. The in
dence of such male or female trees
of considerable importance to pract
ing foresters and horticulturists: if
the male or female trees are cut fr
an area, fertilization will be drastica
reduced so that there will no long
be a source of seed from which t
species can regenerate.

Broad-leaved trees that bear th
flowers in male or female aments, b
have both sexes on the same tree, a
considered to be somewhat more hig
ly evolved than those that bear flowe



D MAPLE flower buds emerge in April before any leaves pear. Flower and leaf buds are separate, and sexes are found on different trees. Here, male flowers are enlarging and a number of the anthers have already shed their pollen.



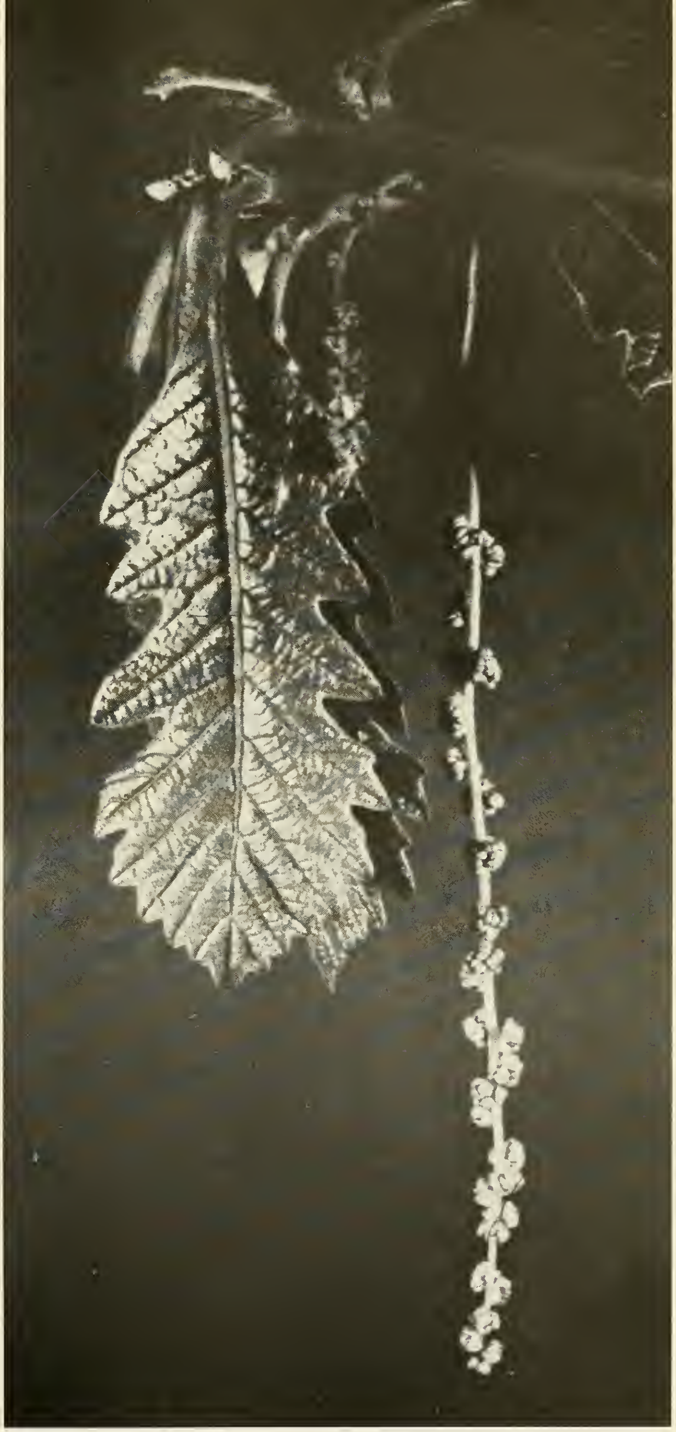
ALE CATKINS of paper birch, *above,* ow on same tree as do female variety.

only one sex. The familiar gray and per birches are good examples. One usual feature of the birch family is e preformed, staminate aments found the alder, birch, hazelnut, and hop-rnbeam. The male inflorescences ng at the branch tips until early ring, when they distend and shed eir pollen. The female, or pistillate, nents bear a close resemblance to varf spruce cones.

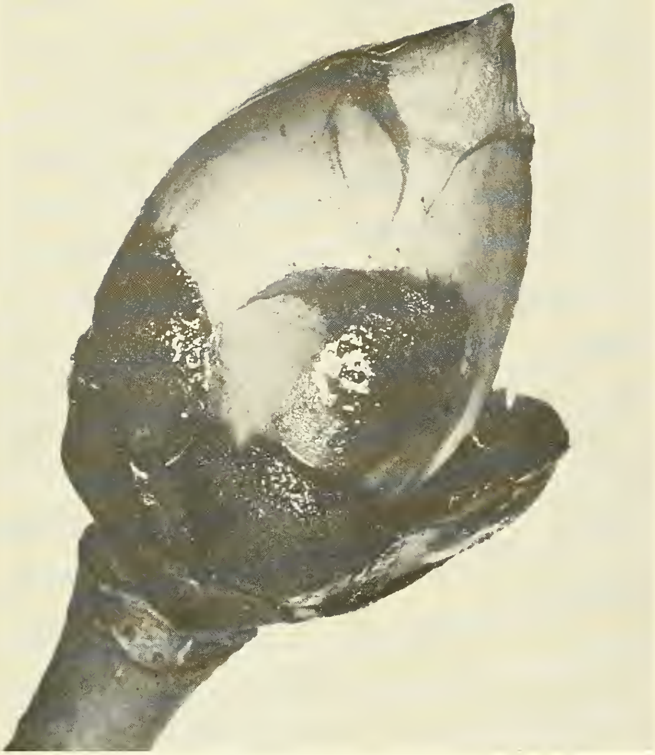
THE oaks also possess male amentiferous flowers (its female flowers e merely an inconspicuous budlike ıster), and the American chestnut ars both male and female flowers in e catkin-like cluster.

In contrast to the unisexual, amenerous trees there is another category, mposed of species that bear both sexual and unisexual flowers that are t in aments. In this group, reprented by the elms, hackberries, and ulberries, petals are still lacking. A ose examination of American elm igs during the winter season reveals o types of buds. One—shaped like small dome, about an eighth of an ch long—contains the unexpanded ig and leaves of the spring growth. ne other, about twice as large as the af bud, contains compressed clusters

EE LEAVES of the black oak, *left,* d its male flowers form in same bud.



GREENISH-YELLOW male flower of the swamp white oak, *above,* is same color as leaves that appear simultaneously. The female catkins are knob-shaped.

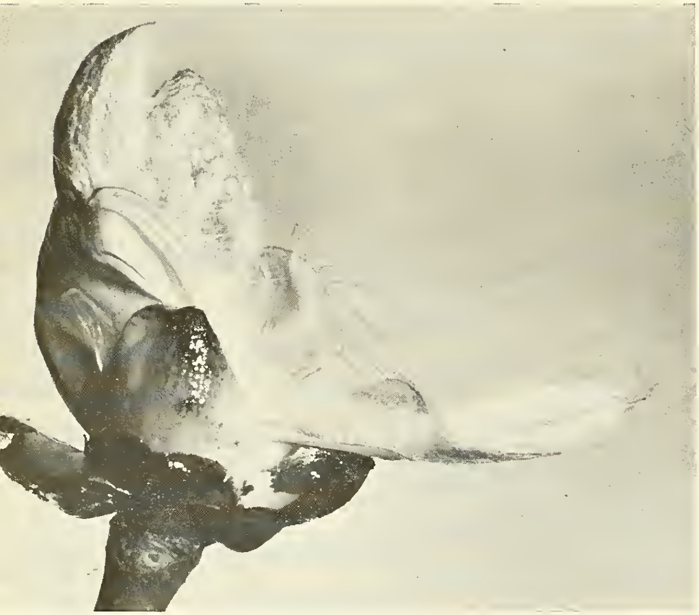


In mid-May, the waxy, sticky buds of the horse-chestnut appear, *above*. As the days lengthen, the dramatic changes seen in this series of pictures occur.

of bisexual flowers, each only a quart
of an inch wide when mature. The
flowers, which appear in late Mar
or early April, begin to mature in
fruit even before the leaf buds burst.

Perhaps the most spectacular tr
blooms of the eastern United States a
found among the magnolias, membe
of the group with separate-petal
flowers. One beautiful native magnol
hardy as far north as New Jersey a
Michigan, is the umbrella magnol
Its snowy-white petals, which compo
a flower one foot in diameter, and t
two-foot leaves that surround it su
gest a tropical origin. The majes
tulip tree, which may reach a tw
hundred-foot height in our easte
forests, bears large, orange and gre
flowers very similar to the magnol
but with more of a garden-tulip for

The much-admired "blossom" of t
flowering dogwood is really not
flower at all. Its petal-like, white bra
are expanded bud scales. In winter, t
scales cover and protect the cent
cluster of the dogwood's true, l
minute, yellow flowers, which a
located in the center of the matu
blossom. Another striking tree flow
is that of the horse-chestnut, a co
monly planted shade tree. The p
mordial flowers of this tree are co



Vital forces of spring cause scales to fold back steadily, *above*, showing overlapping leaves and the embryonic flower cluster at the center of the bud.

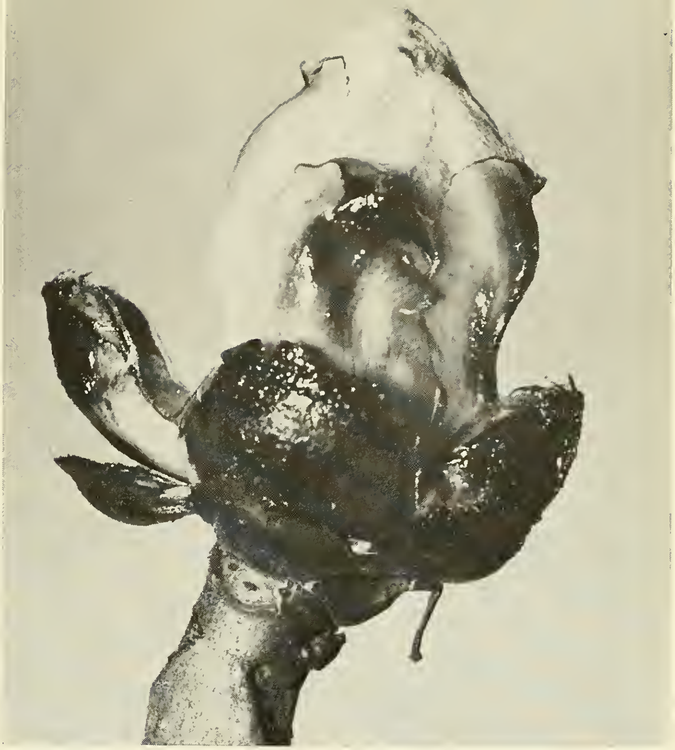
Bud contents are packed in cottor
damp, hairlike material that prote

essed within the same sticky bud as s tiny, preformed leaves. By early ay, the bud scales unfold and within week the tree is covered with large, hite clusters of flowers much relished bumblebees. This tree, a native of sia Minor, is not related to our merican chestnut.

NE of the most highly advanced groups of the flowering plants is at with fused petals, represented nong tree flowers by the tubular blossms of the various ashes, the persimon, and the catalpa.

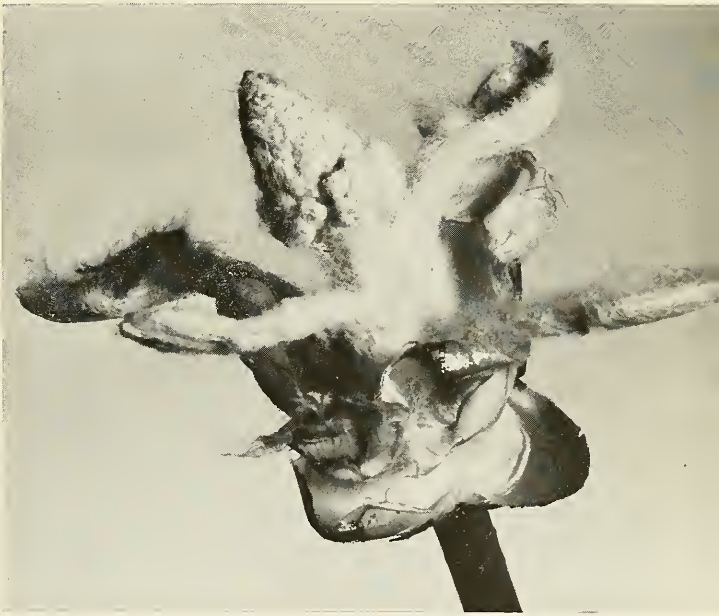
Tree flowers are essential, of course, the perpetuation of the species. The ed—which is the ripened ovule—ntains the hereditary traits evolved ring the long history of the species. d will give rise to new generations trees. The tree produce we eat—ples, pears, peaches, and dozens others—are the ripened parts of e flowers. Another, now neglected, ringtime delicacy is the firm ament the white pine, added to venison w by the Ojibway Indians.

The basswood tree—from which we tain sugary sap, bark for rope and ine, and a valued, ivory-white wood lso bears flowers with many uses. epicurean delicacy is the tangy

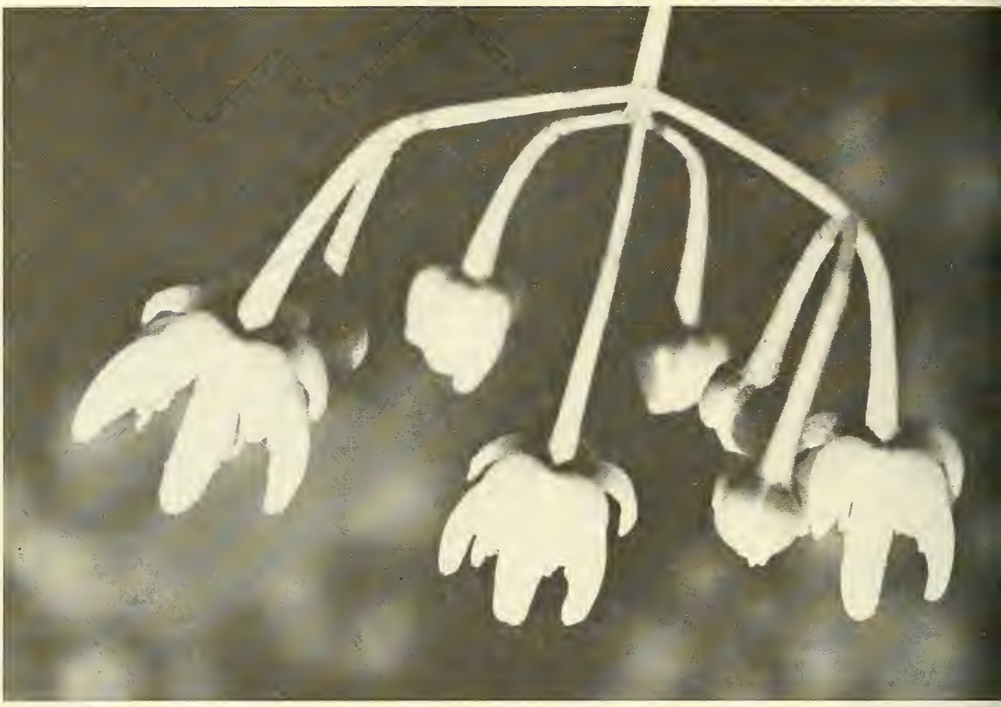


MOISTURE AND SUN are necessary for bud's growth, forcing the outer scales to separate, *above*, exposing outside of the leaves that frame the flowers.

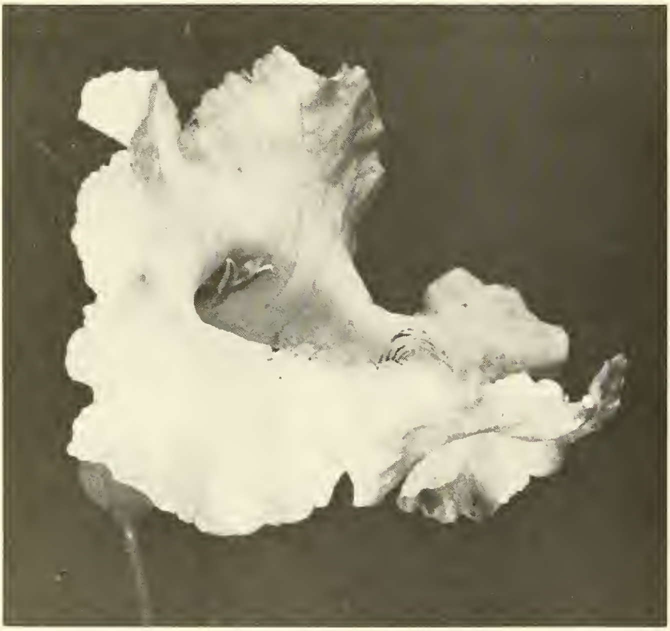
em from rapid change of temperature d from swift or extreme water loss.



SCALES now pull completely away from contents, *above*. Expanding compound leaves and the miniature flower cluster have separated and push into the open.



SUMMER-BLOOMING BASSWOOD, *above*, produces fragrant, cream-colored blossoms that are favorites with bees. Clusters hang beneath elongated, modified leaf, or bract, which
unlike serrated true leaves that emerge before the flow



FUSED PETALS are a characteristic of highly advanced plant groups. Tubular blossom of the catalpa, *above*, appears in late May after leaves are formed.

honey derived from the small yell
flowers. Frederick the Great relish
a chocolate-like confection made fr
the crushed flowers and fruit, a
soldiers of the Confederacy, as well
peoples of Europe, used the aroma
flowers as a substitute for tea. T
redbud, one of our attractive orn
mental trees, bears delicate pink bu
and flowers that can be used in sala
and pickles, or that can be fried
butter. Over the years, tree blosso
have been used in a variety of recip

SYSTEMATIC observations of tr
flowering can be an instructi
and enjoyable realm of natural histo
The dates of bud swelling, flower elo
gation, pollen shedding, fruit enlarg
ment, and final maturation can
noted over several years. The close p
tern of annual coincidence that shou
be established by such observatio
will enable the amateur botanist to pr
dict the date of blossoming in his are

HUGE BLOOM of magnolia tree, *right*,
foot in diameter, with separated peta

Of Love in Infants

udies of monkeys show how affection for mothers is formed

By Harry F. Harlow

HE USE OF INFANT MONKEYS in many laboratory experiments is aps dictated by necessity, but few tists would deny that it is also arkably convenient. Monkeys are better co-ordinated at birth than an infants; their reactions can valuated with confidence at an of ten days or earlier, yet their lopment follows the same general as that of humans.

ne monkeys' well-being and even ival pose a number of problems, ever—particularly if they must, ne course of experimentation, be rated from their mothers only a hours after birth. Nonetheless, ne University of Wisconsin's Pri- Laboratory we were able, using niques developed by Dr. Ger- e van Wagenen of Yale, to rear nt monkeys on the bottle with a lower mortality than is found ng monkeys nursed by their ers. Now one of the components ur technique involved the use of uze diaper folded on the floor ne infant monkeys' cages, follow- Dr. van Wagenen's observations monkeys would maintain con- with soft, pliant surfaces during ing. We were struck by the deep hment our monkeys formed for diaper pads and by the distress showed when, once a day, the were removed for reasons of ation. This observation led us quite a new series of experi- s—research into the importance dily contact in infant love.

VE of infants for their mothers is often regarded as a sacred or ical force, and perhaps this is it has received so little objec- study. But if facts are lacking, theory on this subject is abundant. Psychologists, sociologists, and anthropologists usually hold that the infant's love is learned through the association of the mother's face and body with the alleviation of such physical tensions as hunger and thirst. Psychoanalysts specially emphasize the importance to emotional development of attaining and sucking at the breast. Our experiments suggest something else is involved.

We contrived two substitute "mothers." One was a bare cylinder made of welded wire and surmounted by a wooden head. In the other, the wire framework was covered by a layer of terry cloth. We put eight newborn monkeys in individual cages, each with equal access to a cloth and to a wire mother. Four received their milk from one type of mother, four from the other—the milk being obtained from nursing bottles fixed in the mothers' "breasts."

Physiologically, the two mothers proved to be equivalent—the monkeys in both groups drank as much milk and gained weight at the same rate. But psychologically, the two

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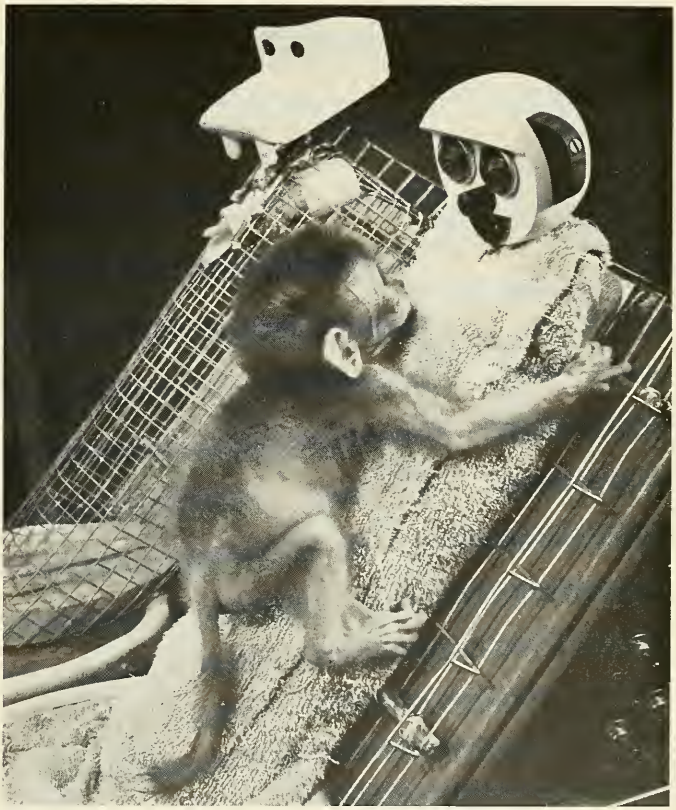
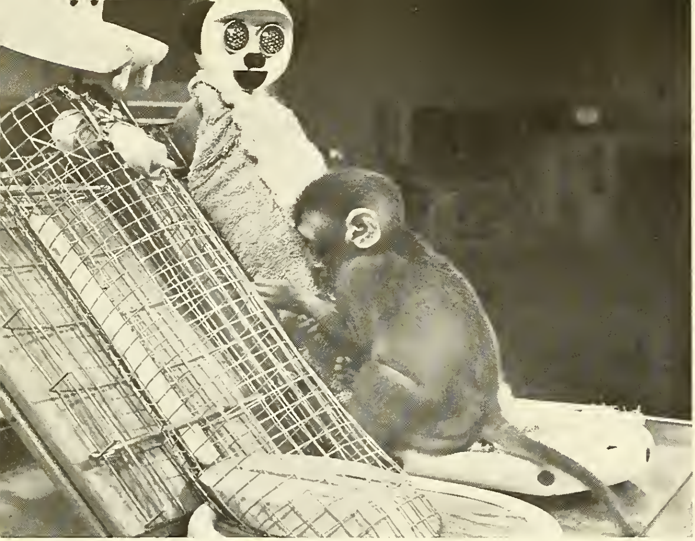
. Harlow, now president of the nerican Psychological Association, a professor of psychology at the niversity of Wisconsin. Gordon ster took the series of pictures.

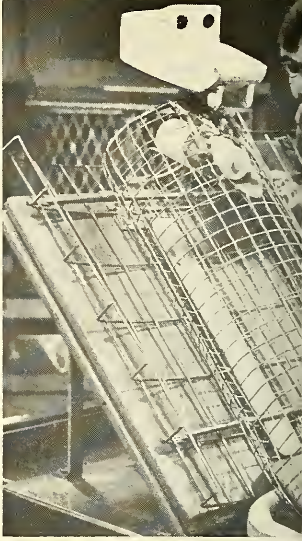
h and wire mother substitutes at were used in tests of infants' love.



Infant monkey, seen clinging to cloth mother, illustrates finding that breast feeding plays small role in infant love, while bodily contact is crucial factor.



Rubbing against toweling, the monkey gives entire attention to cloth mother, ignoring wire mother despite fact that nursing bottle is fixed in its "breast."



Growing hungry, monkey turns to wi
mother with bottle. Physically, if n

mothers were not at all equivalent. Both groups of monkeys spent far more time climbing over and embracing their cloth mothers than they did their plain wire ones; they even left their electric heating pads to climb on the unheated cloth mother. Those that suckled from the wire mother spent no more time than feeding required.

The theory that infant love is related to satisfaction of hunger or thirst was thus contradicted, and the importance of bodily contact in forming affection underscored. This finding was supported by the next phase of our investigation. The time that monkey infants spent cuddling their surrogate mothers was a strong indication of emotional attachment, but it was perhaps not conclusive. Would they also turn to their inanimate mothers for comfort when they were subjected to emotional stress?

With this question in mind. we exposed our infant monkeys to strange objects likely to frighten them. such as a mechanical teddy bear that moved forward, beating a drum. It was found that, whether the infants had nursed on the wire mother or the cloth one, they overwhelmingly sought comfort in stress

from the cloth one. The infant wou
cling to it, rubbing its body agai
the toweling. With its fears th
assuaged. it would turn to look
the previously terrifying bear wit
out the slightest sign of alarm.
might even leave the comfort of
substitute mother to approach t
object that had frightened it on
a minute before.

It is obvious that such behavior
analogous to that of human infan
and we found that the analogy he
in situations that less obviously i
volved stress. If a human child
taken to an unfamiliar place, f
example, he will usually rema

Box experiment is seen here. Monkey looking out through window of box was as interested in cloth mother, *center*, as in another real monkey, *left*. But the response to wire mother, *right*, prov
to be no greater than to an empty roo

otionally, nursing on the wire mother
s as healthful as on the cloth one.

m and happy so long as his
ther is nearby; but if she leaves
n. fear and panic may result. Our
eriments showed a similar effect
infant monkeys. We put the mon-
ys in a room that was much larger
n their usual cages, and in the
m we placed a number of unfa-
liar objects—a crumpled piece of
wspaper, blocks of wood, a metal
te, and a door knob mounted on
ox. If a cloth mother was present,
monkey, at the sight of these
jects, would rush wildly to her
d, rubbing against the toweling,
ng to her tightly. Its fear would
n diminish greatly or else vanish
ogether, as in the previous experi-
nt. Soon the monkey would leave
mother to explore its new world.
now regarded the objects as play-
ngs. Returning from time to time
the mother for reassurance, it fol-
ed an outgoing pattern of behavior.

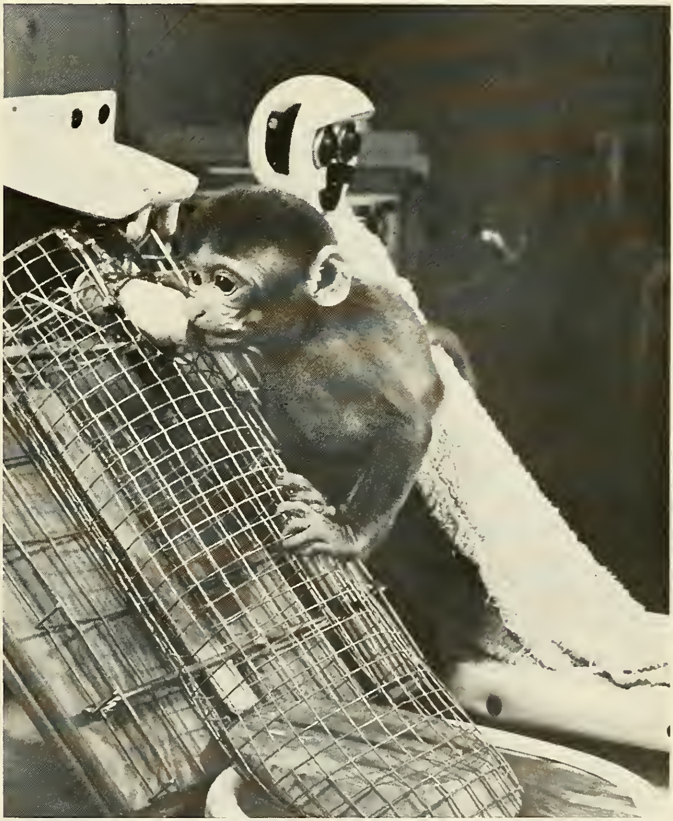
F the cloth mother were absent,
on the other hand, the infant
uld rush across the room and
ow itself head down on the floor,
tching its head and body and
eaming in distress (photographs,
lowing pages). The bare wire
ther afforded no more reassur-
ce than no mother at all—even
nkeys that had known only the
re mother from birth showed no
ection for her and got no comfort
m her presence. Indeed, this group of monkeys showed the greatest distress of all.

In a final comparison of cloth and wire mothers, we adapted an experiment originally devised by Robert A. Butler in this laboratory. Butler had found that monkeys enclosed in a dimly lighted box would press a lever to open and reopen a window for hours on end, with no other reward than the chance to look out. The rate of this action depended on what the monkeys saw: a glimpse of another monkey elicited far more activity than that of an empty room.

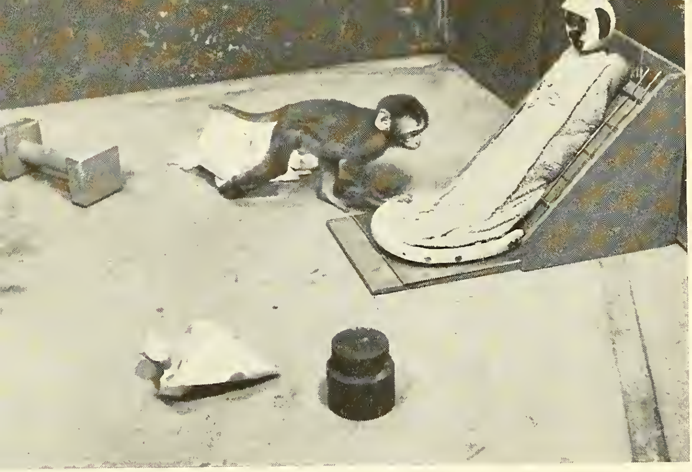
When we tested our infant monkeys in such a box, we found that those raised with both cloth and wire mothers showed as great an interest in the cloth mother as in another monkey, but responded no more to a wire mother than to an empty room. In this test as in all others, the monkeys that had been fed on a wire mother behaved in the same way as those that had been fed on a cloth-covered mother surrogate.

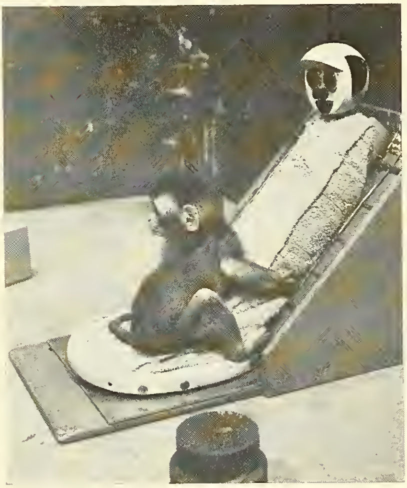
Thus, all objective tests we have been able to devise indicate that the infant monkey's relationship to its substitute mother is a full one. There are, of course, other factors than bodily contact involved. For example, the simple act of clinging, in itself, seems important: a newborn monkey has difficulty surviving in a bare wire cage unless provided with a cone to which it can cling.

Yet our experiments have clearly shown the importance of the comfort derived from bodily contact in the formation of an infant's love for its mother, and revealed the role of breast-feeding to be negligible or non-existent. They have also established an experimental approach to subtle and dramatic relationships.



FEEDING at bottle, monkey pauses for brief time on its wire mother. But once nursing is over, baby will return to its cloth mother, which it clearly prefers.

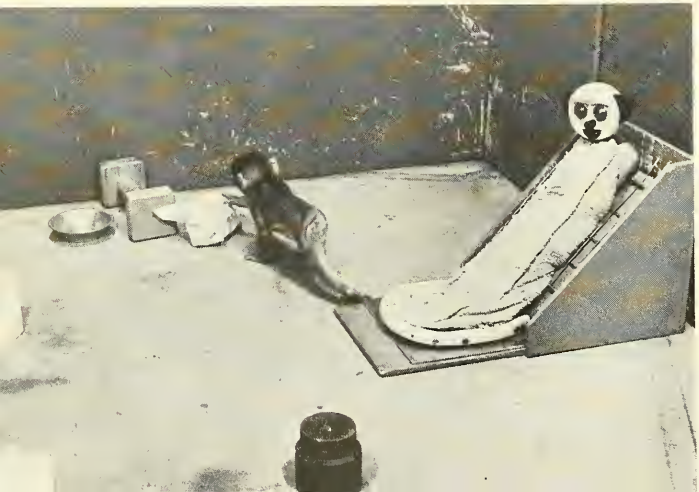


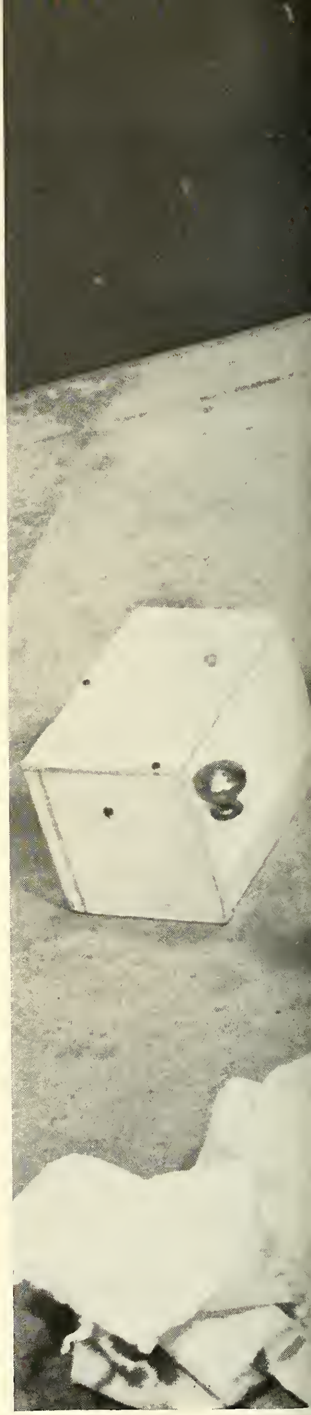


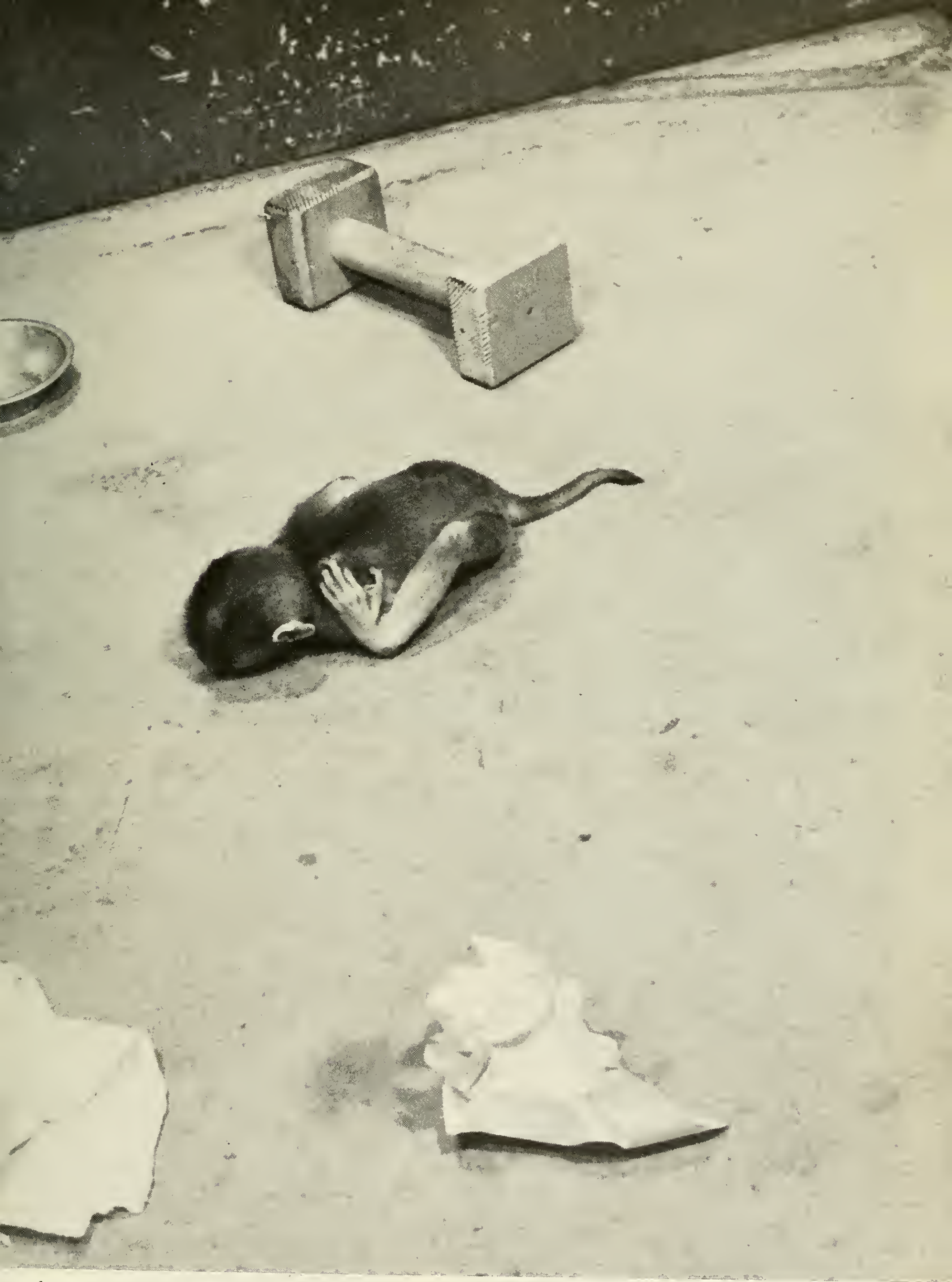
Frightened by many strange objects, monkey seeks comfort from its cloth mother, *above.*

Hugging cloth mother, a baby monkey obtains reassurance from texture of toweling, *left.*

Confident again, the monkey leaves its mother to investigate new objects around it, *below.*







IFIED by strange environment, baby monkey is unable to n composure in absence of cloth mother. Wire mother was of no more comfort than no mother: in fact, the monkeys that had had only a wire mother were most distressed of all.

Slain hippopotamus, *above*, is a day's food for many Tonga. Now taken with guns, beasts were once speared from canoes.

Part II:

A Zambezi People's Food Quest

In this river culture, game and fish supplement farm produce

By Thayer Scudder

During the twelve months I spent in a survey of the human geography of the Middle Zambezi Valley (Natural History, April, 1960) I found it an incredibly beautiful place much of the time. Seated outside a thatched hut on a sunny day, with a fresh breeze blowing off the Zambezi only a few hundred yards away, I even at times considered the Valley an earthly paradise. And so it may be to the European who is not tied to the land. But to the agriculturally inclined African, the area is one of the harsher environments that a man may attempt to farm. Not only is he plagued by the fickle Zambezi and the extremely irregular rainfall, but his crops are also threatened by insects, birds, and mammals, his livestock by predators and sleeping sickness, and his own body by a variety of ailments.

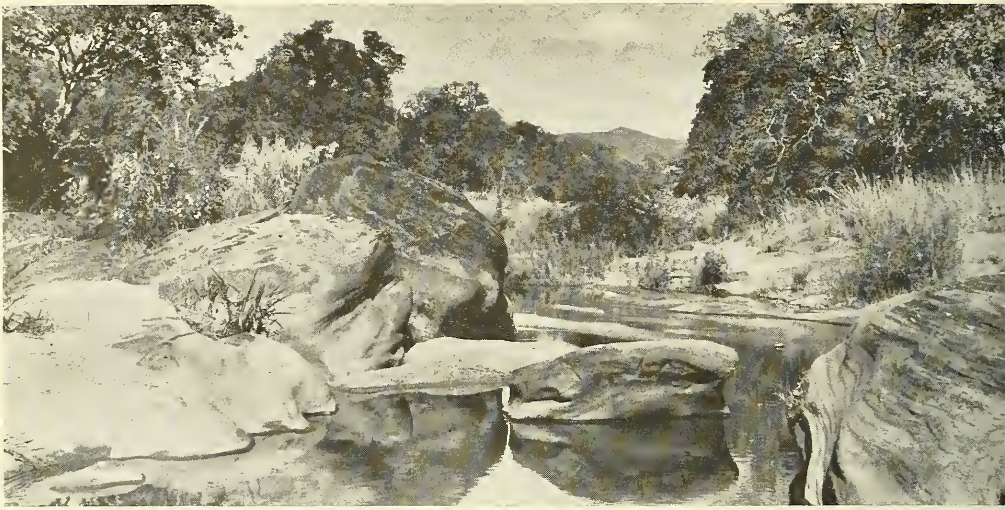
Disease is prevalent throughout the area. Malaria is endemic, along with elephantiasis, bilharzia, leprosy, and the human form of sleeping sickness—although the latter is found only in restricted areas today. At the beginning of the rainy season, with sudden changes in humidity and temperature, many people are struck down with illness and confined to their huts at the very time when sowing the fields is essential. For, if planting is late, wild grasses are already well up, threatening to choke off the germinating food crops unless immediate cultivation is completed. Indeed, causes of crop failure are many, and no harvest is assured until it has been stored safely within village granaries. Even then, termites and rot must be reckoned with.

Noose snare, *below*, used to capture smaller game, can be set in different ways, depending on the animal to be caught.

Under such circumstances it is not surprising that har-
ts in certain areas are insufficient nearly every year.
en, more than ever, people are thrown back on the nat-
l produce of their environment—which is insufficient to
port such a large population. The result has been peri-
ic famine. On the other hand, whereas famine is the re-
t of insufficient quantity of food when grain crops fail,
diet of the Valley Tonga appears at least adequate in
ality—judging from the general absence of obvious diet-
deficiencies and the nature of supplementary food ma-
ials utilized. These include other cultivated crops, such
cucurbits, sweet potatoes, beans, and peanuts, and a tre-
ndous variety of animals and uncultivated plants. The
undance of wild produce, in fact, makes the Middle Zam-
zi Valley a far more suitable habitat for a small popula-
n of hunters and gatherers than for an agricultural com-
unity, regardless of the latter's size.

F, as we have seen, existing agricultural practices ap-
pear reasonably well adapted to local conditions, the
me conclusion is even more warranted in regard to fish-
g and hunting techniques. Many observers who consider

Mr. Scudder, a Harvard geographer, here concludes the study of the Valley Tonga that he began last month. It is based on a year's stay with this tribe during 1956-57.

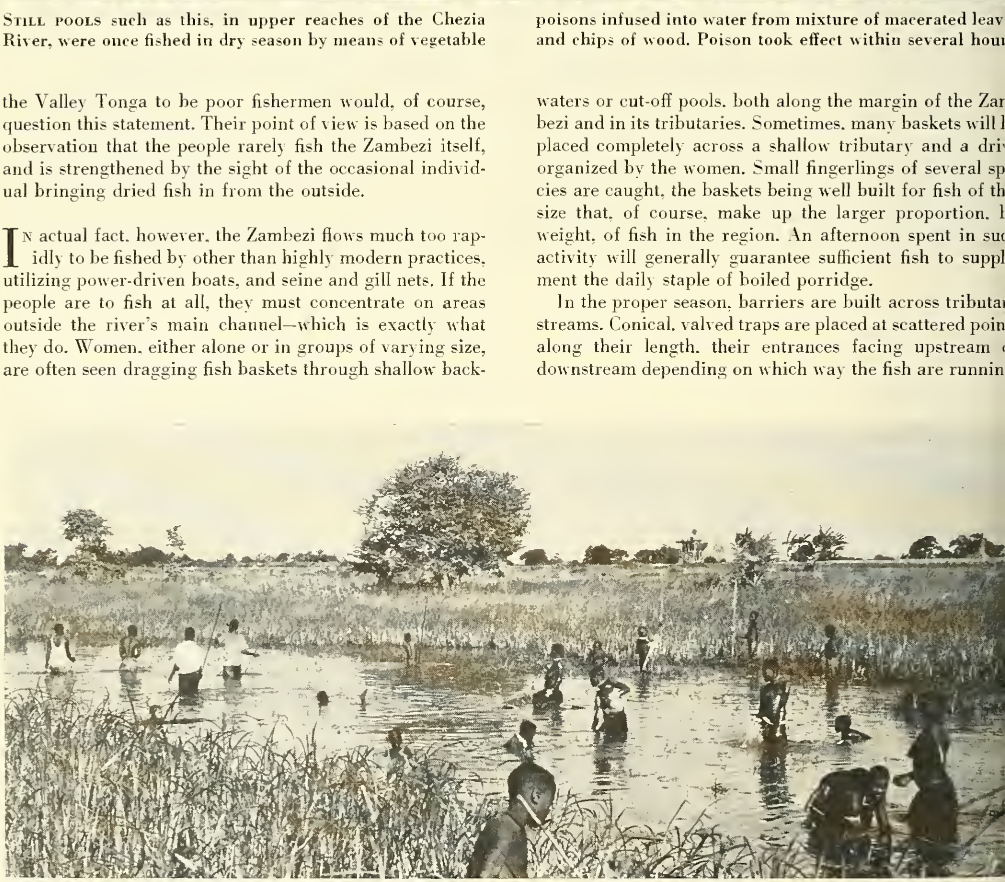


Still pools such as this, in upper reaches of the Chezia River, were once fished in dry season by means of vegetable poisons infused into water from mixture of macerated leav and chips of wood. Poison took effect within several hou

the Valley Tonga to be poor fishermen would, of course, question this statement. Their point of view is based on the observation that the people rarely fish the Zambezi itself, and is strengthened by the sight of the occasional individual bringing dried fish in from the outside.

In actual fact, however, the Zambezi flows much too rapidly to be fished by other than highly modern practices, utilizing power-driven boats, and seine and gill nets. If the people are to fish at all, they must concentrate on areas outside the river's main channel—which is exactly what they do. Women, either alone or in groups of varying size, are often seen dragging fish baskets through shallow backwaters or cut-off pools, both along the margin of the Zar bezi and in its tributaries. Sometimes, many baskets will l placed completely across a shallow tributary and a dri organized by the women. Small fingerlings of several sp cies are caught, the baskets being well built for fish of th size that, of course, make up the larger proportion, l weight, of fish in the region. An afternoon spent in suc activity will generally guarantee sufficient fish to suppl ment the daily staple of boiled porridge.

In the proper season, barriers are built across tributar streams. Conical, valved traps are placed at scattered poin along their length, their entrances facing upstream downstream depending on which way the fish are runnin



Spear fishing is practiced in lower reaches of Zambezi's tributaries, when water backs up from main stream during annual flood. Both a nighttime and a daytime activity, spe fishing is used to take larger fish that swim in with floo

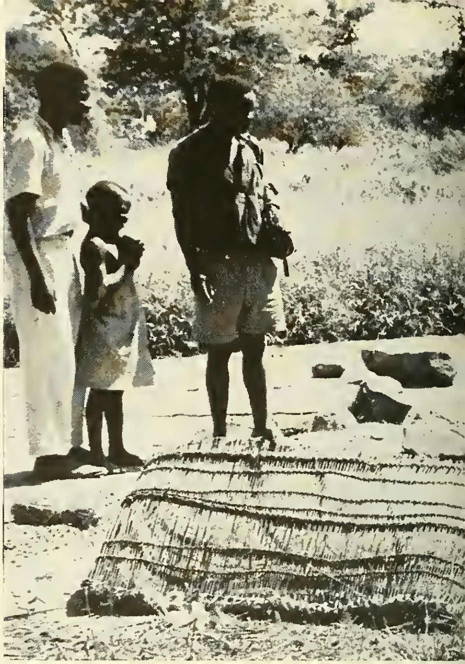
DREN PLAY in newly risen river, unconcerned over the ling of alluvial field. Premature floods at end of wet or dry seasons are a major cause of famine for Valley Tonga, destroying crops along river before they can be harvested

Some months later—if the Zambezi rises in April or May, which is the general pattern—its remarkably silt-free waters push slowly up the lower reaches of the now nearly dry tributaries. Then the men spear fish at night. With the aid of torches they obtain those larger species that move in with the flood. Later. when the Zambezi flood waters recede, shallow portions are cut off by man-made dams of sand or mud, built both in the tributaries and along the margin of the main channel of the Zambezi itself.

The women later scoop out the fish thus trapped with their baskets. If the water is too deep for this, they may speed matters up by shoveling it out with their hands. or with dishes, to the rhythm of their singing. In some tributaries, still larger and deeper pools do not dry up before the next rains. Formerly. these were fished out through use of vegetable poisons *(Adenium multiflorum, Euphorbia ingens,* and *Acacia albida,* to mention three). The proper mixture of macerated leaves and chips of wood from several species was said to be effective within several hours.

Special fish baskets are even made for use in the swift Zambezi. itself. Sizable affairs, these are staked out—in narrow channels permeating mudflats above the water level—just before the Zambezi begins to rise in its primary channel after the onset of the rains. As the water rises, fish swimming through these channels are trapped. The baskets are relocated only after the rising water spreads on either side. Tangle nets—constructed along the lines of a butterfly net but up to six feet long—may also be set in the main channel to catch sizable fish (one to four pounds) that swim close to the shore. These indigenous nets are fastened to a hoop that is attached. in turn. to a long pole secured to the river bank. Smaller nets of this type are also used as scoops by the Valley Tonga fishermen.

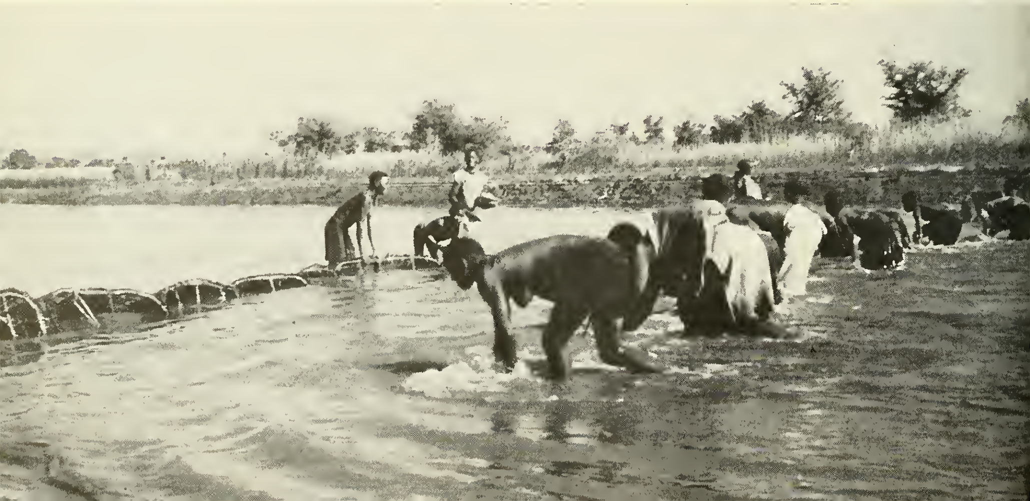
While still other techniques of fishing are known, it should already be clear that the Valley Tonga are well aware of fish as a natural resource within their environment. They obtain fish whenever possible, through techniques adapted to meet specific conditions. Of the different genera collected in the Zambezi by myself and others, (and identified by Government fisheries experts). the Valley Tonga had names for every genus except one (and that found almost



Inspecting wicker baskets, some Tonga get ready to fi
Baskets are used by Tonga women in quiet pools, tributar

exclusively in swifter Zambezi waters). In some cases (
beo altivelus and *L. congoro.* and *Distichodus schenga* a
D. mossambicus, for example) names are even given
species. In other cases, several species are lumped with
one category (example: *Clarias* sp.). Lack of a name, ho
ever, does not necessarily indicate that forms in a gene
category are not distinguished. In several cases, Val
Tonga observers pointed out morphological differen

Trapping fish, a group of women drive them into line of baskets placed across Chezia River. Baskets may face either
downstream or up, depending on which way fish are runni
and are used chiefly to catch fingerlings, not larger fi



e Zambezi, or its backwaters—the river's main channel s too swiftly and can be fished only with tangle nets.

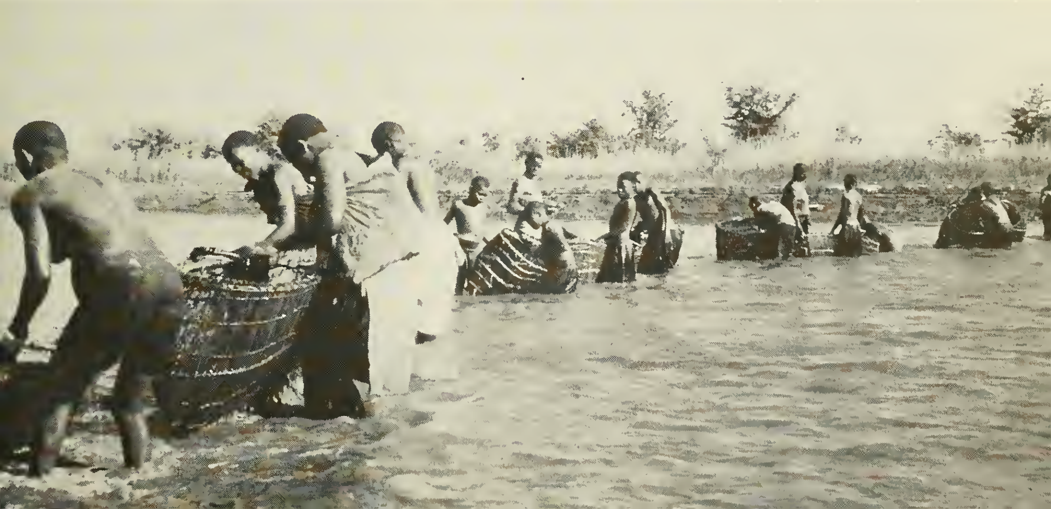
, for unknown reasons, did not warrant terminological nction between the fish species concerned.

hen the Valley Tonga are resettled and the Kariba e fills up, Government hopes that many villages will to fishing, developing the type of small-scale industry exists elsewhere in Central Africa. Full-time specializa- , with boats and nets, could allow entire villages to sup- themselves on the basis of fishing. This is especially important in areas where population increase will soon outstrip agricultural production. Although major changes in social organization must accompany any conversion of fishing from a respected part-time activity to a full-time occupation, there is little reason to believe that the Valley Tonga, with patient instruction, will not be able to make this transition. In 1956-57 a number of Valley Tonga already owned gill nets, some of which were used on a full-time basis when the Zambezi flood backed up into the lower reaches of certain major tributaries.

PRACTICALLY every day, someone in a Valley Tonga family brings in some source of animal protein to add to the pot. While fish provided a major source in 1956, frogs and lizards, birds, rodents, and larger mammals also played an important role, as did those domestic animals that either died or were slaughtered for social or ritual purposes. Regardless of the time of year, some such source of animal protein is available. During the height of the rainy season, small boys frequently return after a day of herding with a string of large frogs. The end of the rains anticipates the beginning of the rodent season—during which women and children may spend an hour or so each day digging small rodents (such as *Saccostomys* sp.) out of the ground. A species of larger termite, caught some years in tremendous numbers at the start of the rains, is fried and eaten. Although primarily considered a delicacy, these insects also play their seasonal role in expanding the protein diet.

While fishing techniques, as we have seen, are adapted to various water conditions rather than to the various species of fish, hunting techniques are ingeniously adapted to the habits of the animals involved. Although variations were to be expected to suit different mammals, I was interested to find noose-snares also set specifically for different kinds of birds—such as sandpipers, drongos, green pigeons, doves, rollers, and even small raptors. Indeed, the proliferation of hunting and trapping techniques for all sorts of game was quite amazing. A spring-pole snare would be changed in specific details depending on whether the hunter was after a jackal, a mongoose, or a duiker. This sort of variation is, of course, in addition to the trap being

MINING THEIR CATCH, women lift baskets out of water. ing has an important role in the life of Valley Tonga, whose language is rich in terms to designate various fish: all genera that are caught have names, as do many species.



situated where the particular beast was most likely to pass. In the case of jackals, for example, a hollow log would slip down the snare rope after the trigger mechanism was released. to prevent the captured animal from gnawing away the fiber rope ensnaring its foot. Bait for a mongoose, in contrast, would be placed in the bottom of a small. open pit, so that the animal would have to thrust his head through the noose to retrieve it.

A generation ago. big game hunting was considerably more important than today. A larger human population. with many more guns than in the past. has driven much of the remaining game back into isolated areas. In the interests of conservation, game laws at present are rigorously enforced and many indigenous hunting techniques have become illegal. No longer are hippopotomi in the Zambezi harpooned from dugouts. or elephants speared from trees with poisoned blades. Although pits are still dug to trap these same animals. and snares set for eland and other large antelope, these techniques. too, are rapidly dying out, along with the ritual that accompanied them. Hunting shrines still exist. but in many cases the owner only digs a token pit or sets a token snare to appease the ancestors from whom his techniques were inherited.

Like fishing and hunting, gathering also plays a role in the food economy far more important than the actual quantity of produce collected in this manner might indicate. Different types of vegetation are associated with different soils and water conditions so that. within walking distance of any village. there are several vegetation complexes. each with its distinctive species. The people have an intimate knowledge of many of these plants—used for ritual and curative purposes. as well as for food. Throughout the year. fruits of one kind or another are available, and the Valley Tonga select certain types for consumption depending on the season. Nutritional analyses by W. R. Carr, of the Federation Ministry of Health. would seem to indicate that the fruits most important in the food economy are those with the highest ascorbic acid—Vitamin C—concentrations (baobab, *Adansonia digitata* for example).

Other wild food plants—such as grasses, tubers, and leaf spinaches—may also be critically important sources of vitamins and minerals otherwise absent in the diet. Unfortunately. few nutritional analyses of these wild food plants have been made and many more data are needed. The fact remains, however. that the Valley Tonga are acutely aware of the plant resources of their environment and the women spend considerable time throughout the year collecting and preparing certain plants as they come into season.

When the Kariba Dam was completed, in December, 1958. over 40,000 Valley Tonga already had been resettled. By 1962, when the new lake will be stabilized within its basin, slightly over 50,000 people will have been moved. Although all the major resettlement areas are located within the Middle Zambezi Valley, the environment of these areas differs in many respects from that of the Valley Tonga's former villages along the Zambezi and the lower reaches of its tributaries. Because of the close relationship between environment and Valley Tonga culture, these differences will stimulate changes within the subsistence economy and social system of the people. Changes in the size o individual settlements have already occurred, since soils i the resettlement areas cannot support population densitie equivalent to those of the fertile alluvia.

Other changes are inevitable. In the immediate future the Valley Tonga will have to reorient themselves to a situation where dry season crops are no longer possible an where new soil and rainfall conditions will not permit th same agricultural practices. Because rain shrines and ritua leaders are tied to certain areas *(katongo)*. which will soo be inundated, many aspects of the religious system mus undergo change if this system is not to be permanentl

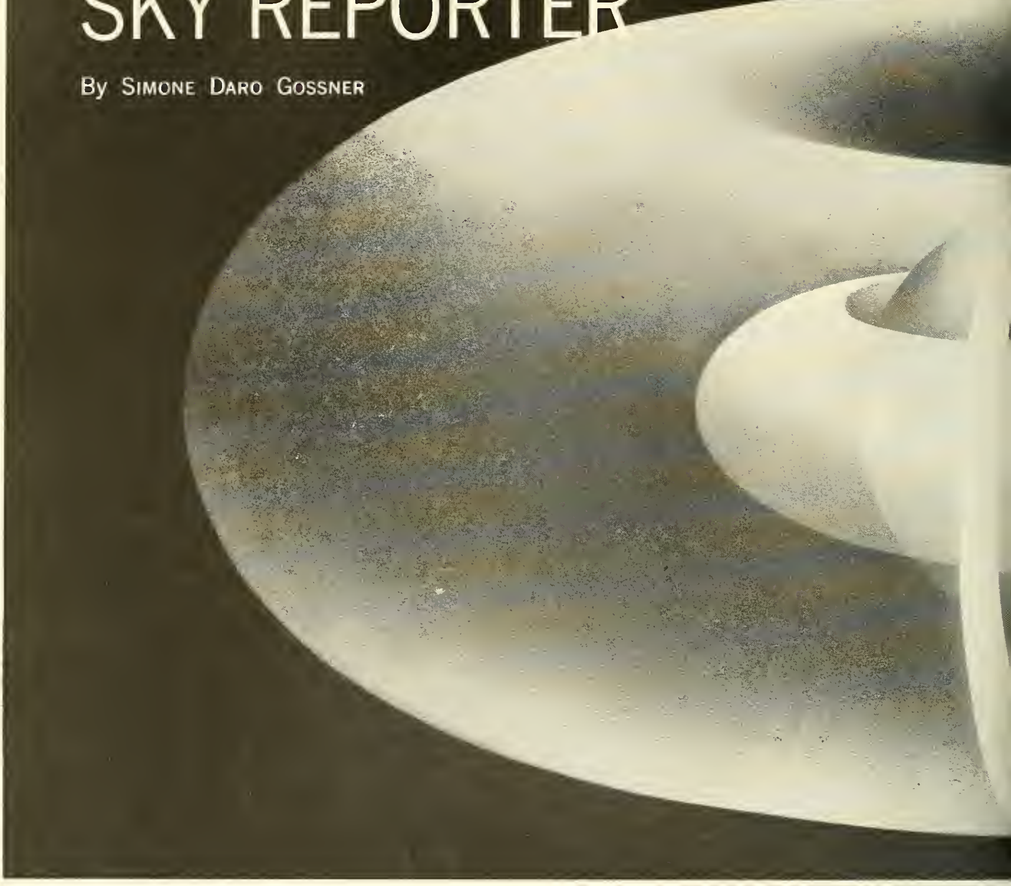
Wooded valley some fifteen miles inland from the Zambezi is typical of areas where Valley Tonga are being resettled.

kened through resettlement. The new homes of the Val-
Tonga have long been settled by other Tonga, whose
ure differs in many respects from that of the resettled
ple. It remains to be seen whether or not the ritual and
tical leaders of the Valley Tonga will be able to transfer
r authority to the resettlement areas.

R. Colson and I plan to return periodically to the resettlement areas to observe whatever changes occur
iin Valley Tonga society, and correlate these changes
rever possible with conditions in the resettled peoples'
physical and social environment. Our first restudy is
ned for 1962. At that time, we will be able to observe the extent to which the people have adapted their subsistence economy to their new environment, and the effect to date that the social system of the indigenous Tonga has had on Valley Tonga society. We will also be able to check the validity of predictions we have made concerning specific changes, and to formulate new predictions for the future. Because of the size of the population involved, we have an unparalleled opportunity to carry on through time a study that could have considerable theoretical importance concerning the processes of social change in underdeveloped areas, although it remains to be seen whether or not our eventual conclusions will be applicable to other societies that must be shifted from one location to another.

SKY REPORTER

By Simone Daro Gossner

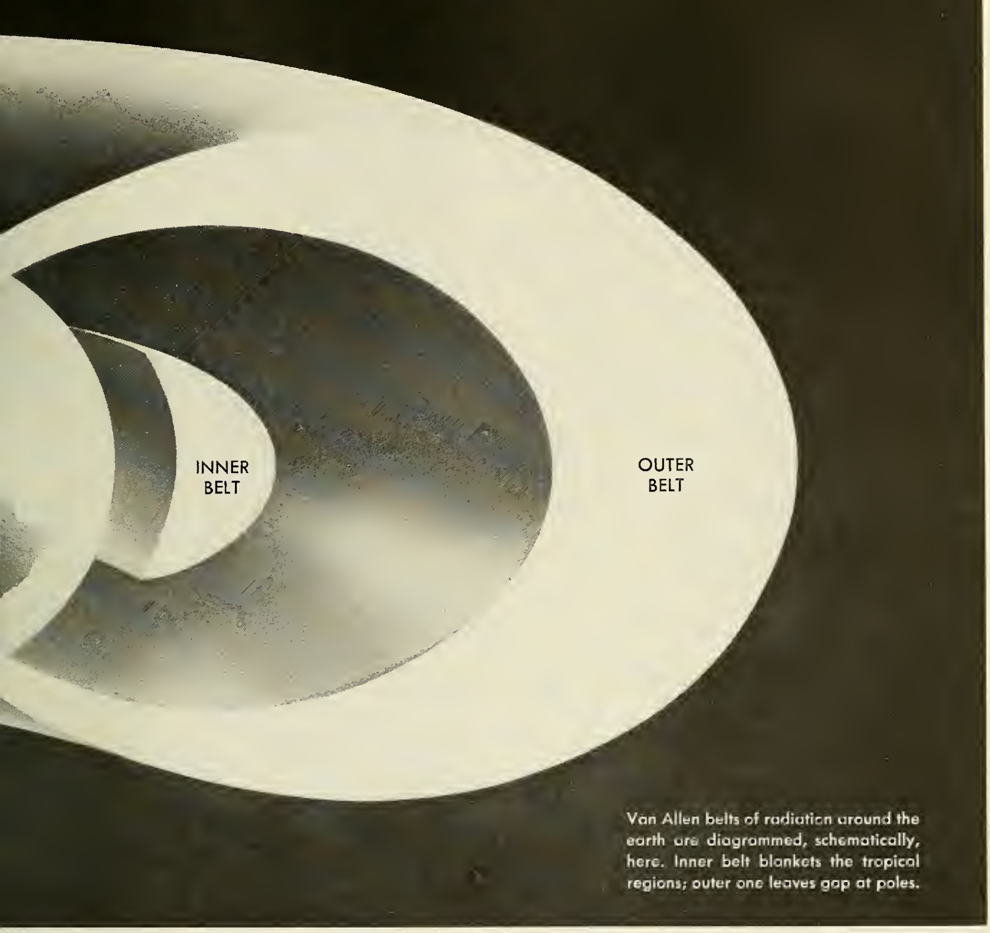


Two of America's first satellites, Explorer I and III (launched on January 31 and March 26, 1958), may have looked tiny in comparison with their Russian counterparts, but they were destined to bring about a complete revolution in our understanding of the earth's upper atmosphere.

Explorer I carried aloft a simple Geiger counter, for the purpose of observing cosmic rays, and some broadcasting apparatus to send these observations back to earth. The experiment had been devised by Dr. James A. Van Allen and his collaborators, at the State University of Iowa. It may be recalled that the satellite had an elongated and very eccentric orbit. Whenever it passed close to the earth, its Geiger counter readings proved to be in good agreement with values obtained from earlier rocket soundings. But when it traveled to the far reaches of its orbit, the results were at complete variance with anticipations.

Suspecting a malfunction of the equipment, Dr. Van Allen and his group repeated the experiment with Explorer III (Explorer II had failed to orbit). The new results were no less remarkable. At high altitudes, the radiation counts were so high that the counter jammed, in spite of the fact that it had been built to withstand as much as a thousand times the counting rate expected from cosmic rays alone. There could be no doubt that a region of extremely high radiation had been discovered in the outer regions of the earth's atmosphere. Immediate plans were made to keep the region under observation by means of more refined equipment. Radiation counters were included in all later U. S. satellites and in the lunar probes (Pioneers). As the gigantic jigsaw puzzle of ob servations was gradually fitted t gether, a clearer picture of the phe nomenon began to unfold.

It was found that this intense radia tion is mainly concentrated in tw belts (illustration, *above*). The inne belt lies mostly above the equatoria and tropical regions of the earth. It maximum intensity occurs at abou 2,000 miles from the earth's surface The outer belt envelops both the inne belt and most of the earth, but curve in toward the earth's surface just shor of the poles. The peak intensity of th outer belt above the Equator is foun at about 10,000 miles, beyond whic it decreases gradually. The entire re gion of radiation seems to extend t about 60,000 miles.



Van Allen belts of radiation around the earth are diagrammed, schematically, here. Inner belt blankets the tropical regions; outer one leaves gap at poles.

he Van Allen belts are composed of
trically charged particles trapped
ne earth's magnetic field. This fact
lains the characteristic shape of
belts, which follows closely the
ern of the magnetic lines of force.
nature of these charged particles
ifficult to determine at the present
e, and is still the object of much
oretical speculation. It is believed
the outer belt is constituted almost
rely of free electrons. The intensity
he radiation within that belt fluctu-
widely and seems to be affected
he occurrence of solar flares (sud-
disturbances on the surface of the
). This would indicate that the par-
es in the outer belt are of solar
gin. The inner belt, on the other
d, seems to contain protons (hy-
gen nuclei) as well as electrons. It
nuch more stable than the other,

RADIO TRANSMITTER, part of Explorer VII's instrument load, is shown here. Radio, triggered by ground control, then relayed radiation measurements.

and has not shown any appreciable change in the two years that it has been under observation. There is evidence to support the current theory that the particles in the inner belt originate from the radioactive decay of terrestrial neutrons.

THE SKY IN MAY

From the Almanac:

First Quarter:	May 3, 8:01 P.M., EST
Full Moon:	May 11, 12:43 A.M., EST
Last Quarter:	May 17, 2:55 P.M., EST
New Moon:	May 25, 7:27 A.M., EST

For the vis.

Mars, Jupiter, and Saturn will be the planets most favorably located for observation in the month of May. Mercury will be too close to the sun in the early part of the month. It will be in superior conjunction on May 17, and will enter the evening sky on that date. Toward the end of May, it will set an hour and a quarter after sunset, and may be found very low in the northwestern sky on May 31. Its magnitude on that date will be −0.8.

Venus (magnitude −3.3) will rise less than thirty minutes before sunrise during all of May. Observations will be difficult because of the planet's closeness to the sun.

Mars (magnitude +1.2), in the constellation Pisces, will rise in the east at approximately 3:00 A.M., local standard time, on May 1, 2:30 A.M. on May 15, and 2:00 A.M. on May 31. It will be in the southeastern sky at sunrise.

Jupiter (magnitude −2.1), in Sagittarius, will rise at 11:00 P.M., local standard time, on May 1, 10:00 P.M. on May 15, and 8:45 P.M. on May 31. It will rise in the southeast and will be west of the meridian by dawn.

Saturn (magnitude +0.6), in Sagittarius, will be found east of Jupiter, rising at midnight, local standard time, on May 1, 11:00 P.M. on May 15, and 9:45 P.M. on May 31.

The Eta Aquarid meteor shower will reach its peak on May 4-5, with a probable maximum rate of twenty meteors per hour. The moon, a day past first quarter on that date, will have set before this shower's radiant rises. Look southeast between 2:00 A.M. and 4:00 A.M. Some meteors belonging to this shower may be seen from May 1 to 10.

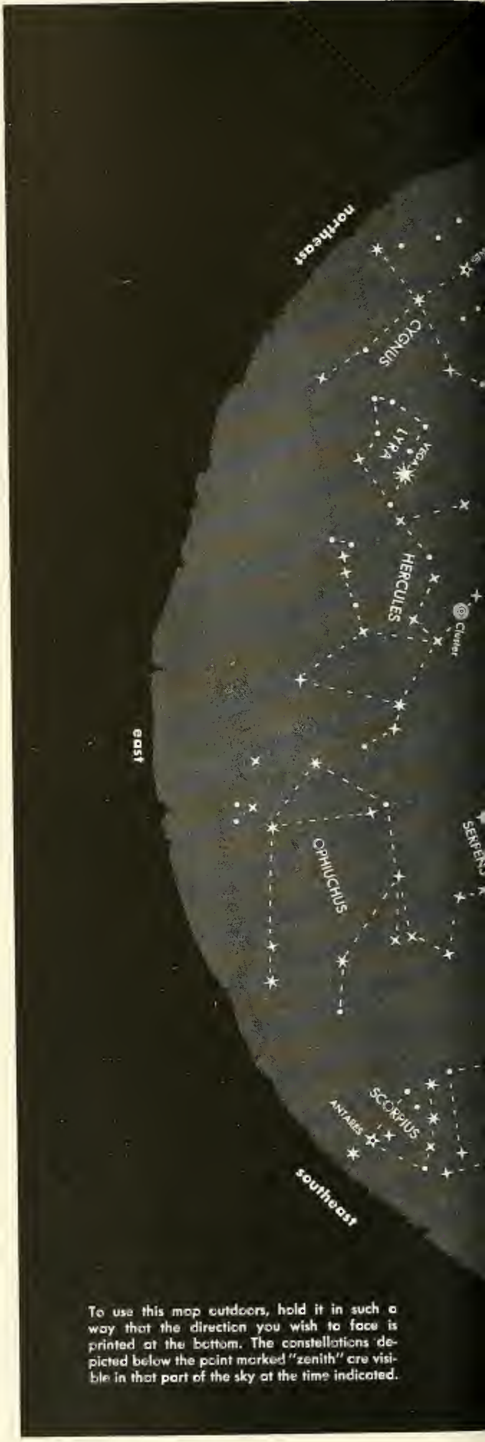
For binoculars and small telescopes:

Although they are visible to the naked eye, the following objects, appearing in the evening sky in May (see map), are seen to better advantage with a small instrument.

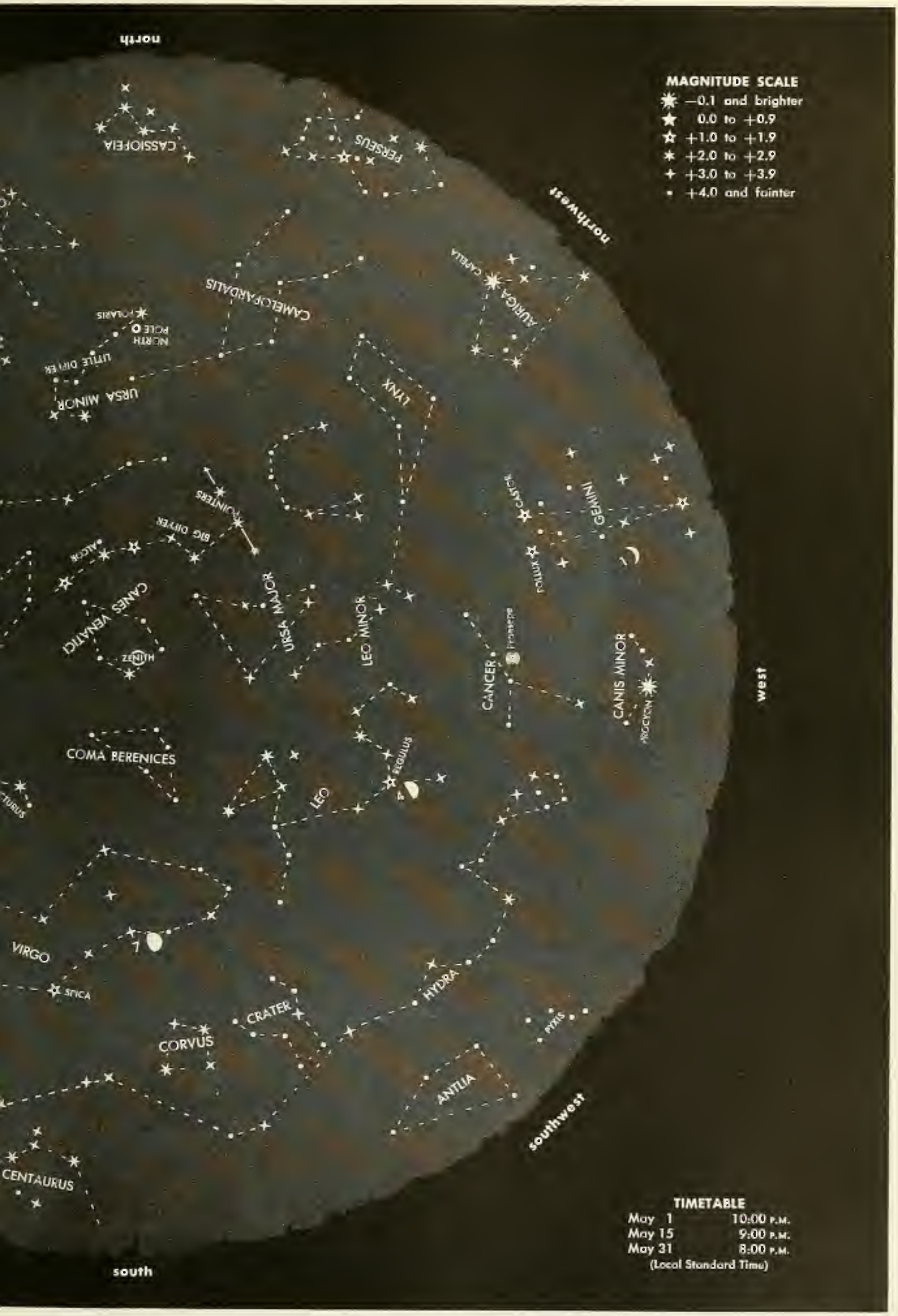
Praesepe, also called the "Beehive," is located in the constellation Cancer. It is a loose aggregate of stars, known as an open, or galactic cluster. All the stars composing it share the same motion in space. Because of its large angular extent, it is seen best at low power.

The Great Cluster, in the constellation Hercules, provides a striking contrast with Praesepe. This is a globular cluster, containing many thousands of bright stars, densely packed into a spherical shape. Some estimates place the total number of stars within the Hercules cluster at well over a million. A six-inch telescope should reveal individual stars in the center of the cluster.

The former Astronomy Editor for NATURE Magazine, MRS. GOSSNER, continues in that role for NATURAL HISTORY.



To use this map outdoors, hold it in such a way that the direction you wish to face is printed at the bottom. The constellations depicted below the point marked "zenith" are visible in that part of the sky at the time indicated.


north
CASSIOPEIA
PERSEUS
northwest
CAPELLA
AURIGA
CAMELOPARDALIS
POLARIS
NORTH POLE
LITTLE DIPPER
URSA MINOR
LYNX
POINTERS
BIG DIPPER
ALCOR
CANES VENATICI
ZENITH
URSA MAJOR
LEO MINOR
CASTOR
GEMINI
POLLUX
Praesepe
CANCER
CANIS MINOR
PROCYON
west
COMA BERENICES
TURUS
LEO
REGULUS
4
VIRGO
7
SPICA
CRATER
CORVUS
HYDRA
PYXIS
ANTLIA
southwest
CENTAURUS
south

MAGNITUDE SCALE

✸ −0.1 and brighter
★ 0.0 to +0.9
☆ +1.0 to +1.9
✶ +2.0 to +2.9
✦ +3.0 to +3.9
• +4.0 and fainter

TIMETABLE

May 1	10:00 P.M.
May 15	9:00 P.M.
May 31	8:00 P.M.

(Local Standard Time)

The First Hawaiians

olynesian Pioneers

By Edward Joesting

Photographs by Ansel Adams

THE EARLIEST ORIGIN of the Polynesian explorers who sailed through the South Pacific and eventually reached the Hawaiian Islands is a mystery that may never be fully solved. However. from bits of evidence gathered through the years, some intelligent speculations can be voiced concerning those early Pacific pioneers.

The race of people we know as the Polynesians probably migrated, in the course of centuries, from the Asian mainland (from as far as India? Almost certainly from as far as Southeast Asia) toward the archipelago of Indonesia. Pushed on—perhaps by the pressure of warring tribes behind them or by their own restlessness—they eventually became acquainted with the hundreds of islands. large and small, that constitute Indonesia.

It is likely that these proto-Polynesians first learned seamanship in this archipelago's relatively safe and narrow channels, gradually changing from land-dwellers to a race of sailors. In more and more daring ventures, they sailed eastward. entering the open sea. hoping to find islands somewhere over the horizon. From the first of these groups—the islands of Melanesia—the pioneers sailed east into the far vaster. watery triangle, the islands of which make up today's Polynesia. The experience of each new generation helped to perfect the great ocean-going canoes and added bits of information to the seafarers' lore about stars, currents. winds, and seasons.

Through the study of basic vocabulary it has been determined that the ultimate source of the Polynesian language can be traced to prehistoric Indonesia. As the Polynesians moved eastward, these Indonesian words—farther and farther from their source—became worn down to simpler forms. By studying the amount of change in the Polynesian language and estimating the length of time required for such changes to take place, Dr. S. H. Elbert of the University of Hawaii has estimated that by at least 1500 B.C. the western border of Polynesia was occupied. Using the same measure, it is estimated that Tahiti was occupied by Polynesians by 550 B.C. From Tahiti. the restless ones moved on to Hawaii. Recent radiocarbon tests from the earliest known camp sites in Hawaii indicate that these islands—some 2,200 sea miles from the Societies—were being occupied by A.D. 500. The twin-hulled voyaging canoes, which brought the first Polynesians northward from Tahiti. were probably similar to the great canoes that Captain Cook saw in use, 1,300 years later, in Hawaii (see illustration, top of page 41).

KONA COAST of Hawaii and the gentle slope of Mauna Loa, viewed across Kealakekua Bay in the illustration at left, formed background for death scene of Captain James Cook.

THESE canoes varied greatly in size. One measured by Cook's expedition was seventy feet long. twelve feet broad. and nearly three and one-half feet deep. There are reports of canoes over one hundred feet in length. which could carry up to one hundred forty men.

The twin hulls of the canoes were fastened together by several stout booms. The underbody of each hull was made from one piece of wood and the other parts were carefully fitted, lashed, and calked. A platform was lashed to the top of the booms between the hulls. Passengers and cargo were carried on this platform, three or four feet above the water. The hulls themselves were reserved for paddlers. During bad weather, mat coverings were placed over the hulls to avoid swamping. Koa wood was the material most commonly used for canoe construction, although drifting trunks of Oregon pine, carried by the prevailing currents. were highly prized whenever they were discovered.

The canoes were propelled both by paddlers and by a single triangular sail. made of matting, which was rigged from a mast set on the platform. A helmsman steered from a position aft on the platform. Canoes were given names. as were the large steering paddles. There was usually little ornamentation on the canoes. although a statue of a god might be carried at the stern.

When the first pioneers' canoes touched shore in the Hawaiian Islands. the voyagers saw little to encourage them. Untouched by human beings and thousands of miles from any other land, many plant species had evolved from a small, initial endowment of plant families. The same held true of the native fauna—birds, insects, and land snails. Hawaii was a bleak place for human habitation.

The Polynesians, however, brought to the islands an impressive number of plants that they had found useful in their old homes: ginger, several varieties of yan gourd, taro, ti, banana plants, bamboo, hibiscus, mou tain apple, sweet potato. breadfruit, sugar cane, t coconut, turmeric. and several kinds of mulberries. Th brought four kinds of animals to their new home as w —the pig, dog, chicken and, as stowaways, the rat.

TOWERING over luxuriant plant life of rain-forest floor, in Hawaii National Park, are tree-fern boles and fronds.

COCONUT PALM, brought to Hawaii by pioneer Polynesia provided leaves for housing. fibers for rope, and cocon

ALL these new plants were strong competitors for spa with the indigenous plant life that had develop in relative isolation. They spread quickly, sometim almost eliminating the native flora. As a result, nati birds. insects. and land snails also suffered both fr the gradual decrease of familiar flora and from t introduction of the hardier strains the voyagers broug with them. Many of the new plants needed no speci care. The staple food plants. however. had to be ca fully cultivated. Chief among these was taro, a larg leafed plant that grows to a height of eighteen twenty-four inches. The root of this plant, pounded a paste, produced their poi—the gray, starchy food th is still popular in Hawaii. Farmers toiled with a sing crude instrument. For breaking and cultivating the ea they used long, sharp-pointed sticks of hard wood. Ta patches were usually located near streams so that t fields could be kept under water, in much the sa manner as rice fields. Sweet potatoes were another imp

eat and milk as food. Coconut makes best growth near salt
ater, and is thus a plant of shore line and coastal plain.

nt food source. They were grown in mounds on land
nsidered too dry for taro. Sugar cane was grown in
umps or hedges. Gourds were cultivated as containers.
rrowroot, ti, and turmeric were sometimes cultivated,
though more often they grew wild.

Despite these food crops, fishing was of greater impor-
nce to the first Hawaiians than farming. The Poly-
esians were, first of all, a race of sailors and they
und the new islands' waters swarming with a wide
riety of life. Fishing within the reef was generally the
ore of women and boys. Men fished the open sea.

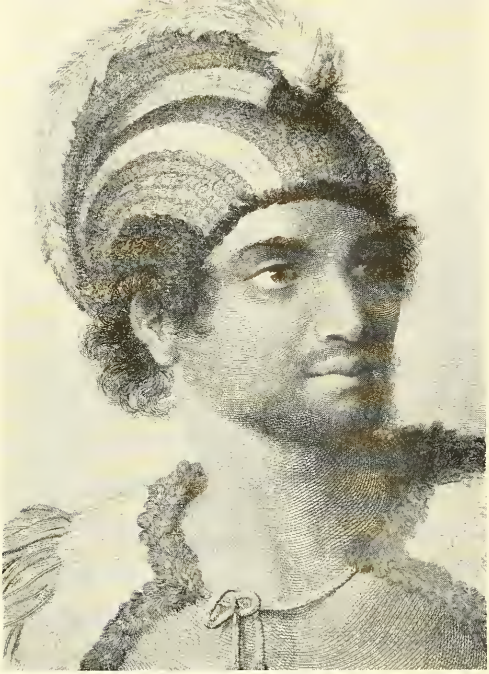
The pioneers developed an assortment of fishing equip-
ent and studied the habits of the local marine animals.
he chief fisherman in a village was an honored person.
ften he had apprentices working under him, learning
ll they could, for many villages were often wholly
ependent on their fishermen for food. Boys first learned
mething of the sea as they helped their mothers or
sters fish inside the reef. They learned to dive to
cate fish, to free nets snagged on rocks, and to set traps.
he boys soon realized that knowing the bottom of the sea
timately was a key to success as fishermen.

When a boy had grown old enough, he went beyond
e reef areas to the open sea. He learned that a fish-
rman can see to a depth of twenty fathoms after kukui
uts were chewed and spat into the water. In deeper
areas, beyond the range of vision, he discovered the best fishing grounds by experimenting with different types of bait and hooks. Live bait was used on the open sea, especially to catch large fish such as bonito. It was thrown into the water as chum, as well as fixed to hooks. Ground bait—strips of fish, cut and pounded—was used both on hooks and thrown into the water to attract fish. Still another bait was made from the ink sacs of squid or octopus, cooked and worked into a paste. The great competition among fishermen meant that the locations of choice fishing grounds—known from cross-bearings previously established on landmarks ashore—were kept as secret as possible.

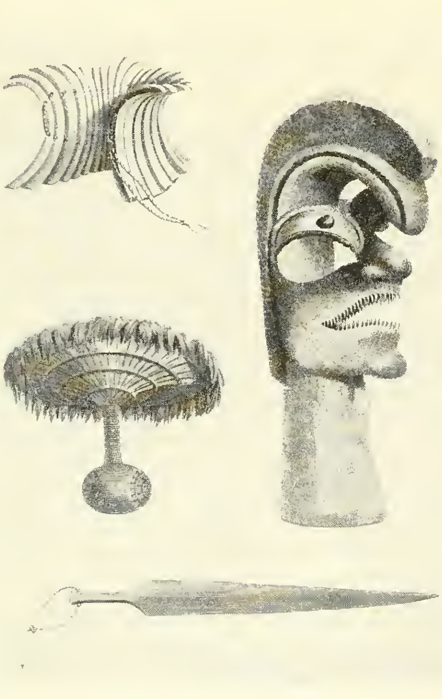
FISHING at sea required considerable equipment: lines (made from twisted fiber of olona bark), hooks of many sizes and types, stone weights and ropes, and nets. Various sorts of nets were used. Net twine also came from olona bark and the nets were woven with the aid of a large netting needle. For certain types, floats were required—often small pieces of wood from the hau tree. The Hawaiians used scoop nets of varying sizes, similar in appearance to those used by trout fishermen today, as well as rectangular dip nets and funnel-shaped ones. Still another method of fishing involved the use of traps. Small, flat traps were used in freshwater streams to catch small fish and shrimp. Larger traps—some funnel-shaped, some cylindrical—were used at sea.

The Hawaiians designated special gods for fishing just as they had gods for other occupations. The principal fishing god was Kuula, a great fisherman of the past. His shrines were heaps of stones by the edge of the water: men going off to sea would contribute a stone to the shrine. Returning from a successful expedition, fishermen would make Kuula an offering of a fish.

LAUHALA, or screw pine, common on windward sides of the Hawaiian group, furnished leaves for matting and thatching.



Helmet, of brightly hued feathers, securely fastened to a basketry framework, denoted the chiefly rank of the wearer.



Hawaiian articles of adornment and worship, *above*, were recorded by J. Webber, the artist with Cook's expedition.

Housing for the Hawaiians was not a critical probl because of the relative uniformity of tempera the year round. Caves were sometimes used as she by the Hawaiians, but more often they were refuges children and old people when warring tribes prese danger. They were also the common place of burial chiefs, and sometimes served as storehouses.

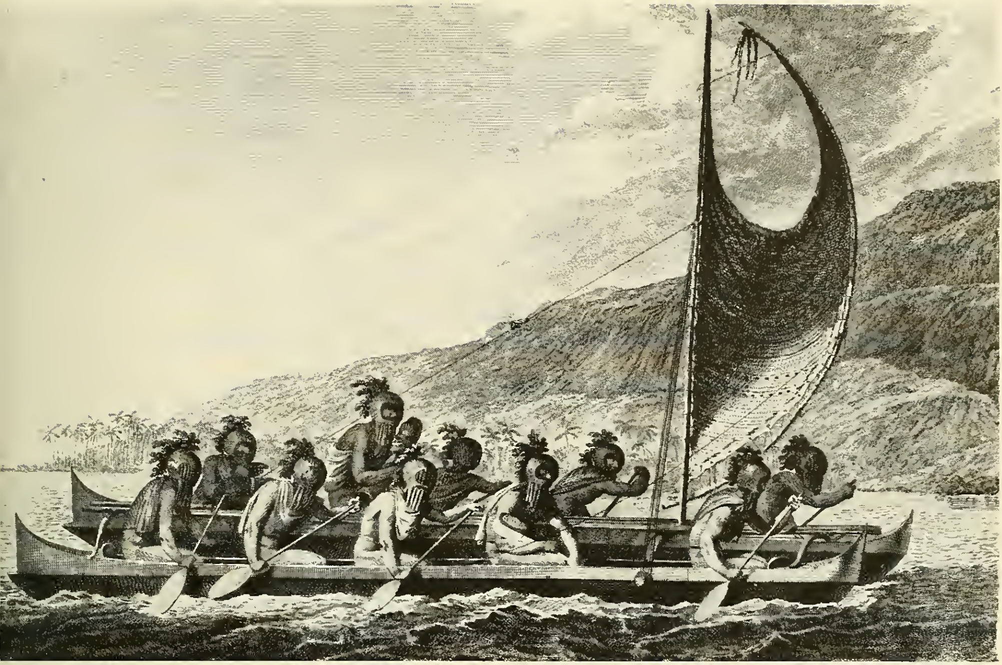
The dwellings that the Hawaiians built were alw rectangular in shape. The home of a chief might from forty to seventy feet in length, while the shel of lower classes were small hovels. sufficient only protect them against rain. The general pattern for h construction started with the builder hiking into mountains to seek suitable trees to serve as house p When the timbers had been cut, they were carrie the building site and set upright in the ground, usu three or four feet apart. Grooves were cut at the of the posts and poles lashed horizontally into pl Higher posts were centered at either narrow end of rectangle and on these was placed the ridgepole framework of small poles and sticks was then lashe the sides and roof. After that began the tedious w of tying leaves or grass to the framework: A variet plant material was suitable for this purpose and usu local availability dictated what would be used, pand leaves, pili grass, ti leaves, sugar cane leaves, or coc fronds. The earth floor of the new house might covered with grass—over which mats were thrown with small pebbles or fragments of lava. The latter se to have been less hospitable to vermin.

The home-building tools of the Hawaiians were and simple. They included, first, the all-important s adz, used both to fell the trees in the forest an groove the posts. Stone rasps were also in the carpen kit, as were crude pump-drills. Post holes were dug the same sort of pointed stick the farmers used.

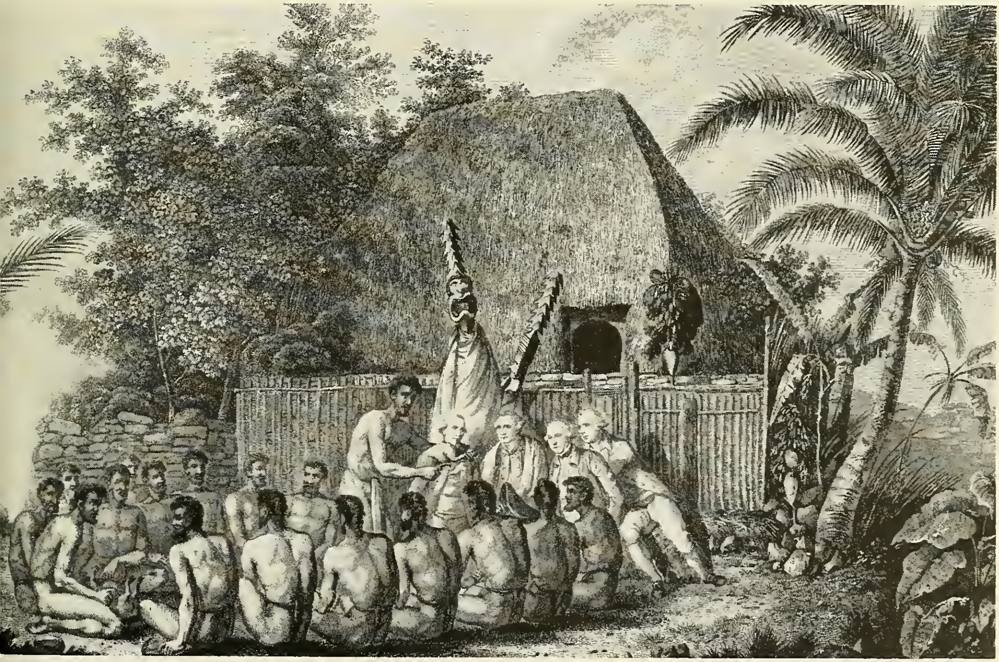
When a house of any size was completed, a kahu as a Polynesian priest was titled—was called to sa prayer at the entrance. Sometimes a ceremony occu in which the grass that hung down over the door was cut away. On occasion, the kahuna would s for a night in the house as a safeguard against spirits that might try to take up residence.

Clothing needs of the Hawaiians were as simpl their need for shelter. The common apparel men consisted only of the malo, or loincloth. The wom costume was a skirt, called a pa'u. Both were of cloth, a tree bark product. Tapa-making was usually w en's work and these steps were required to pro the bark cloth. First, of course, the bark had to stripped from its tree. A number of trees prov usable bark, but that of the paper mulberry, a l carried to Hawaii by the early immigrants, seemed

The bark was soaked in sea water and its outer l removed. Then these prepared sheets were overlayed, on another, so that they formed large pieces. T were beaten firmly until they matted together, and resulting large pieces were then put in the sun to After this, the second stage of manufacture began. sheets were beaten once more, this time with sl square, wooden clubs. Designs, carved in the face these beaters produced patterns on the cloth. Finall number of dyes were used to make decorative des on the surfaces of the finished tapa sheets.



VIN-HULLED voyaging canoes, similar to but larger than ıft above, brought pioneer Polynesians to the Hawaiian group from Society Islands. Cargo platform, supported by booms between hulls, carried mast, freight, and a helmsman.



WAIIAN MEN, clad in simple loincloths. prepare offering food for Captain James Cook and accompanying officers. Typical rectangular dwelling occupies background; visible at right are banana and taro plants, and the coconut palm.

THE Hawaiians' brief apparel was satisfactory in coastal areas, where the majority of the population lived, but it was not enough in the colder and wetter mountain regions. There, additional protection was needed and the garment favored was some sort of cape, a fabric arrangement to which leaves were tied to keep out rain and provide warmth. Undoubtedly the most colorful of Hawaiian apparel were the feather cloaks and helmets that became famous from the time of Captain Cook's visit (illustration, page 40). Such costumes were a designation of social rank in Hawaii, reserved to the chiefs. In all the Pacific, feather capes appear to have developed only within Polynesia and, even in this area, they are found only in New Zealand, Tahiti, and Hawaii. The making of such a garment—a task reserved for men—was a tedious process. Feathers were gathered from five different sorts of birds: the feathers were small and many birds carried only a few feathers of the desired color. It is little wonder that the task was undertaken by professional bird-hunters.

In the early era of Hawaiian settlement, red feathers were the most sought after, probably because red was the traditional color of high chiefs and gods throughout Polynesia. Later, yellow feathers often dominated the garments. Whatever their color, the feathers were secured to a coarse fabric base with the ubiquitous olona fibers and tied so closely together that the resulting surface had the appearance and even the texture of vel

Helmets covered with feathers were the natural c plement to feather cloaks. These were of many typ some bore elaborate, extended crests; others, of sim design, had a single, broad ridge running from fr to back. The early Hawaiians' only other item of w was the sandal, occasionally used when walking ac lava or coral. Sandals were simple arrangements— soles woven of any tough fiber, secured by fiber stra which were tied about the ankles.

EARLY Hawaiians continued in the general patter religious worship that had been brought f southern Polynesia. There were many gods, each usu symbolized by a figure of wood or stone. A god's as ance was gained by reciting prayers and accompany the prayers with offerings. The symbolic figure gai its power only through such means, and not beca of any craftsmanship that had gone into its actual c ing. As a result, the figures were often crude and, some cases, were actually uncarved pieces of wood stone. The pioneers brought four major gods with th from the South Pacific: Ku, Kane, Lono, and Kana They were worshiped by chiefs and commoners al In addition to the major four, innumerable special g were worshiped by persons engaged in different occu tions—for example, Kuula, the previously mentio

STILL IN EVIDENCE on Island of Hawaii are traces of the road constructed during the reign of Kamehameha I, first king of all the Islands. This highway, passing over l flows and across ravines, was used by the royal messeng

NE WALLS in the shallow waters of lee shores created ds, regularly stocked with small fish. Such ponds and waters inside the reefs were fished by the women and boys; men, using variety of hooks and nets, fished the open sea.

ermen's deity. Farmers, bird-catchers, hula dancers, a-makers, even thieves and robbers had their own cial gods. Still other gods were deified ancestors. iefs could be deified immediately after their death, the process of cleaning and preserving their bones.

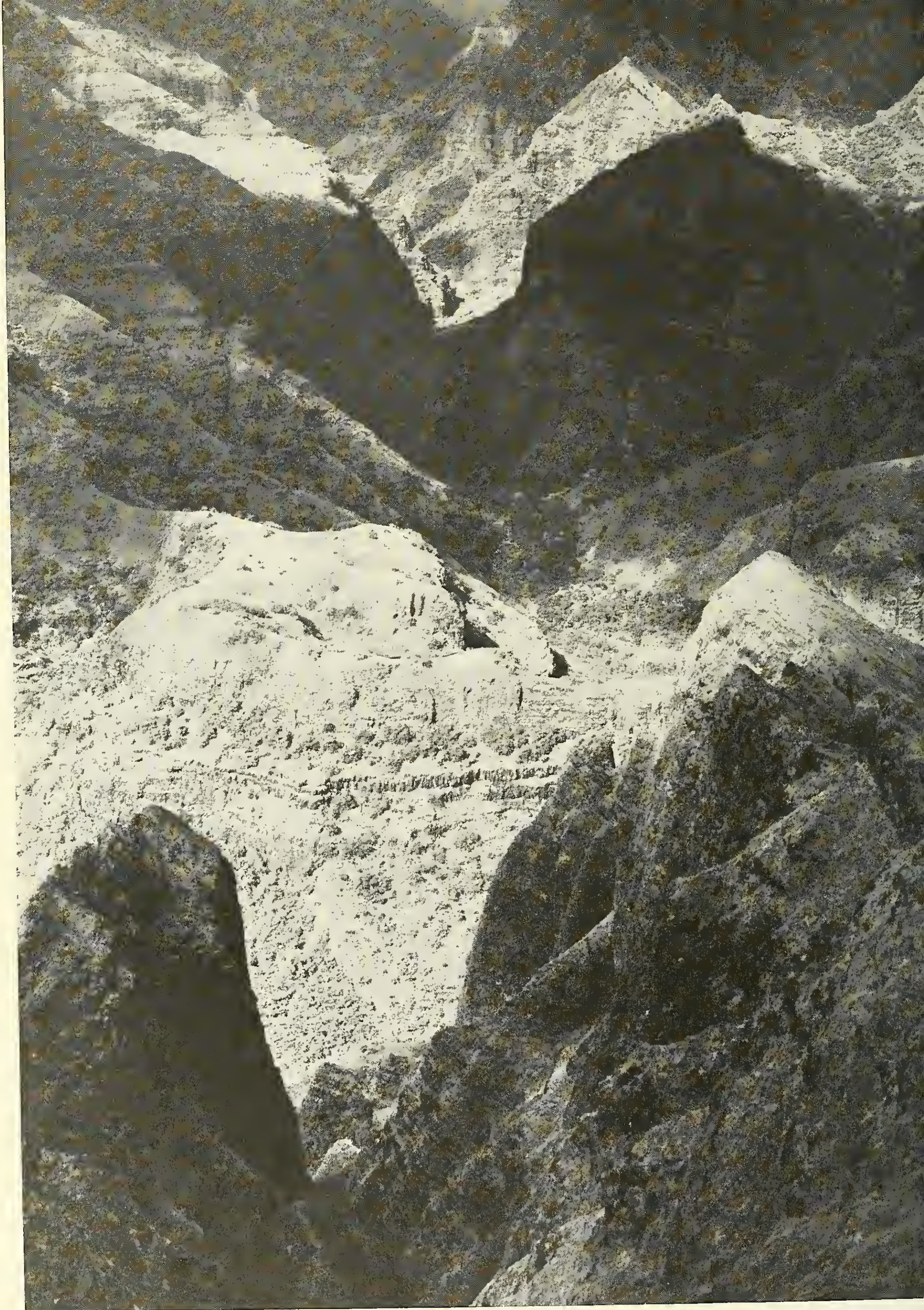
Temples, called heiaus, were important in religious s. They generally consisted of a raised platform, lt of rock. Atop the platform might be a stone or oden fence and several small shelters designed for ious religious functions. An "oracle tower"—a high, n framework, made of poles—was often an impor- t part of the heiau. The temple's god was thought to nmunicate with priests who climbed atop such towers. The heiaus were not constantly in use. Between cere- nies, they were neglected. For routine religious pur- es, a variety of shrines—built along roadways, in ses or any other convenient place—were available. special occasions, however, a chief might decide to duct ceremonies in a heiau, and these might last for s. The ceremonies, which could include the offering human sacrifices, were deemed to provide a chief ine guidance in making decisions affecting his people.

PORTS in primitive Hawaii included swimming, surfing, foot-racing, boxing, and wrestling. Among children's nes were walking on stilts and flying wooden-framed es, covered with tapa cloth or pandanus leaf. Children also played with a kind of spinning top, knew a form of jackstones, and enjoyed whistles and rattles.

The Hawaiians came by swimming and surfing naturally. Both body-surfing and board-surfing were popular. The boards were of two general sizes: the shorter, six to nine feet in length, and the longer approximately fifteen feet. These longer boards could weigh as much as one hundred and fifty pounds. Surfers would lie flat on their boards and paddle offshore to where the long, ocean rollers began to break. Selecting a suitable wave, each surfer would match its speed shoreward and then ride the crest toward the beach: skilled riders could sit, kneel, or stand on their boards as they raced with the wave toward land.

Another sport involved sledding down steep hillsides. A smooth, sloping runway was constructed and covered with grass. Some participants used only a cluster of ti leaves as sleds, but chiefs had special sleds that were equipped with wooden runners.

Adult games were often simple in nature. One guessing game, called no'a, pitted two teams of five against each other in trying to guess under which of several piles of tapa the opposing team had hidden the no'a, or stone. Games of skill, such as throwing spears at a mark or rolling disks in competitions for accuracy or distance, were popular. One such game of skill involved a stick with a loop at one end and a ball attached to the



CANYON trenched by Waimea River on Kauai Island shows in horizontal lines of ragged walls the innumerable flows of lava—continuing today on Island of Hawaii—that slowly built up archipelago from floor of the deep P k by a string: the object was to throw the ball in air and have it pass through the loop. Other pastimes luded konane, a game very much like checkers. Black l white pebbles were the pieces: the game was played ier on boards or upon flat rocks.

LTHOUGH the early Hawaiians developed a variety of musical instruments, they knew only one stringed rument before European contact. This was a musical v, from seventeen to twenty-four inches in length, ally with three strings of twisted cord. The nose e, an instrument made of bamboo, was used exten- ely. The left nostril was held shut while playing, and right nostril placed over a small hole. Such flutes l from one to three finger holes. Gourd whistles were ular. Small, pear-shaped gourds were selected, air was wn through a nose hole, and the number of finger holes ally made in such whistles was three.

hell trumpets served a practical purpose: the sound m these instruments would carry for as much as two es. The usual types were made from the conch (or ton) shell and the Cassis shell, with a hole drilled about the third whorl to serve as a mouthpiece. he Hawaiians devised a number of drums, usually de of hollowed coconut logs with drumheads of shark- n. A short drum was used for the hula, and a taller for religious ceremonies. A type of knee drum was ilarly constructed and tied just above the knee so t the player could beat it with one hand while king a larger drum with the other. Drums were made by combining a large gourd, with the top off, and a small gourd, inverted and glued into circular hole. Such gourd drums are still used in waii. Lengths of bamboo, open at one end, were de to sound by pounding them on stones in time h the music. Other instruments included bamboo ks, about twenty inches long, split for most of their gth into thin sections, small stones—used castanet- hion—and rattles that were fashioned from gourds, nboo, and coconut shells.

EATH and burial in early Hawaii involved special ceremonies. The relatives and friends of the dead ıld show their sorrow by cutting their hair in some uliar way, or by more permanently disfiguring their lies. Such ceremonial disfigurement might include cking out a tooth, tattooing the tongue or burning face or arm to produce a scar. When a person d, a kapu, or "keep out" sign, was placed on his ise and was not removed until the corpse had been osed of. Any person who broke this kapu had to lergo ceremonial cleansing.

odies were wrapped in successive sheets of tapa, a 1, inner sheet and one or more thicker ones. Some- es an additional wrapping of mat was added. On asion, corpses were burned and the surviving bones ined and kept. Relatives might divide the bones among m and then eventually place them together in a ying place. Bodies that were kept intact were buried, ier stretched full length or with the knees pulled vard to the chest. The latter style of burial seems to e been usual with commoners. Burial could occur at umber of sites. Chiefs were usually buried, secretly, caves. Commoners were most often buried in sand

Poi-pounder, at left, and a small stone tiki, at right, were fashioned from Islands' coarse-grained volcanic rock.

Polynesians had no written language, but petroglyphs like this one, of religious significance, were cut into rocks.

Edward Joesting, author of numerous articles about the Pacific area, produced this study of aboriginal Hawaii in collaboration with noted photographer **Ansel Adams**. The illustrations are drawn from a volume on our newest state produced by them for the Bishop National Bank of Hawaii.

hills. Other burial sites included stone cists or platforms built slightly off the ground.

Gradually, the idea of preserving only the skull and leg bones of chiefs seems to have evolved. After Captain Cook was killed, the Hawaiians treated his body in this way and these few remains were eventually returned to the British sailors. In death, Cook therefore was honored as a chief in the traditional Hawaiian way.

In first discovering the Hawaiian Islands for the Western world in 1778, Cook had stumbled upon a population of some 300,000, participating in a highly organized, feudal society that knew nothing of the existence of metals or a written language. This society was never the same again. Following discovery, the islands became popular ports of call for whalers and traders on long Pacific voyages. Soon, European settlers came and the Neolithic civilization of Hawaii was catapulted into the eighteenth century. Old methods and old mores, followed from the beginning of time, were shattered by new techniques and principles. When King Kamehameha I died, in 1819, the society's last prop was pulled out. The old gods and the traditional religious system fell before the enthusiastic teachings of the first New England missionaries.

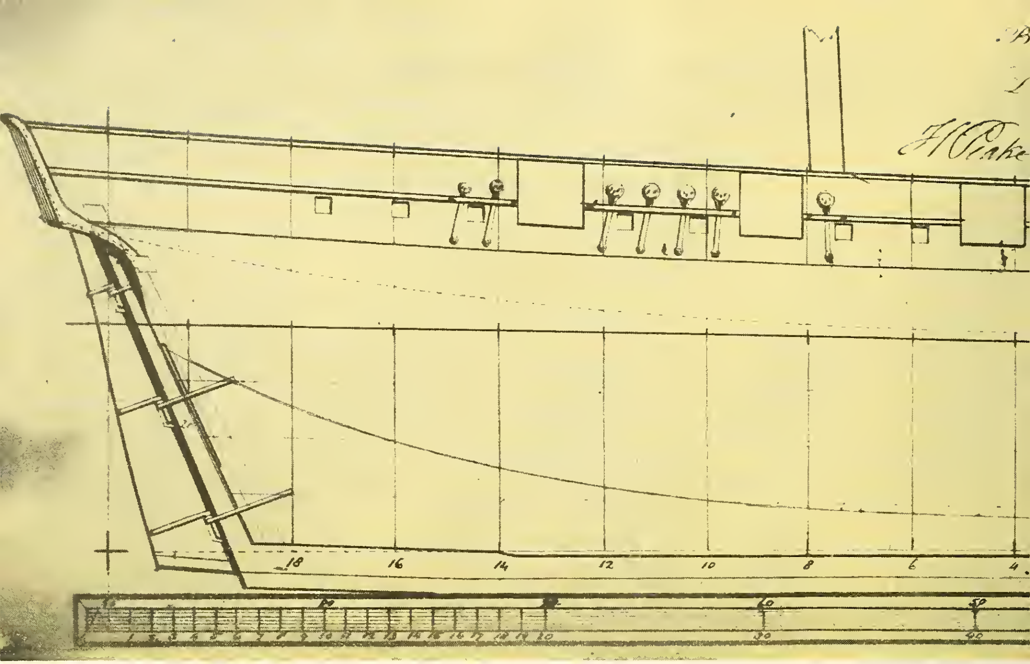
Those who held to the old ways were no match for the newcomers. For generations, the Hawaiians had known only a non-competitive, communal life. The sudden transition was too great: the Hawaiians became, in a real sense, strangers in a land they had occupied for some thirteen hundred years. Not only were the old standards shattered but, by 1872, the Hawaiian population had dropped to less than 60,000 persons—a decline brought about partially by a low birth rate, but principally by diseases against which the Hawaiians had no immunity. Common Western maladies, such as the flu or measles, wiped out entire families and even whole villages in a few weeks' time.

As agriculture became increasingly important in the new order of affairs, the bulk of the land passed from the native Hawaiians into the hands of the Western settlers. Field laborers were essential to the plantations: first Portuguese, then Chinese, Koreans, Japanese, and eventually Filipinos were brought to the Islands. Many of the surviving Hawaiians intermarried, particularly with the Western settlers and the Chinese, and began to produce a part-Hawaiian population. Today, the Islands contain only 11,000 or so persons of pure Hawaiian blood and some 75,000 others who can claim part-Hawaiian ancestry.

After one hundred and eighty-two years, the few remaining pure Hawaiians—less than four per cent of the prediscovery population—have not made much progress by the standards of Western society. Those who live in the cities are mainly employed in manual labor. Most are to be found on the less populated islands of the chain. They prefer isolated areas and a simple existence, a taro patch, and fish from the sea satisfying their needs.

Kalalau Valley, nestled between the cloud-capped r
of Kauai Island's north coast, was heavily populat

y times, although now deserted. Hawaiians, numbering e than a quarter-million at the time of Captain Cook's visit, have since then been reduced by intermarriage and Western diseases to a small handful of the original stock.



ADMIRALTY DRAWING of 1817, *above*, shows a profile of the class of ten-gun brig to which the *Beagle* belonged. Small mizzenmast was added to the *Beagle*, to make her stee easier. Thus, while known as a brig, she was really a b

The “Beagle”– a searc for a lost ship

Darwin's voyage is immortal. But what did his vessel look lik

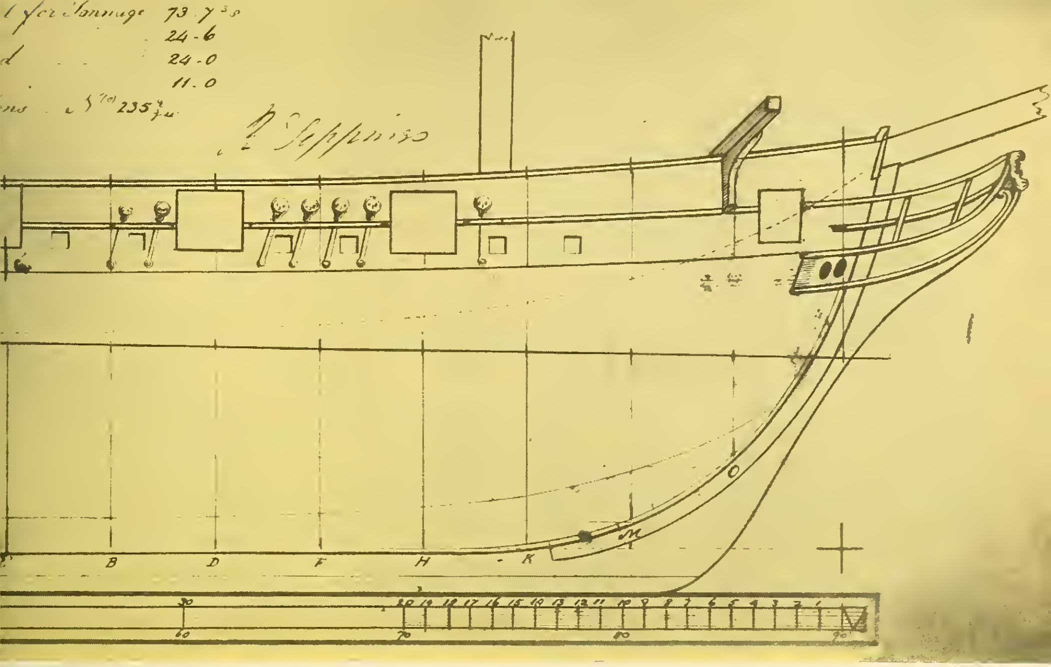
By LOIS DARLING

HONORS HAVE BEEN GIVEN and fine models made of great sailing ships with well-known names and bellicose histories—the *Constitution*, the *Constellation*, the *Bon Homme Richard*, H.M.S. *Victory*, even the ugly *Monitor*. But a small ship, quietly going about her business in the search for human knowledge and understanding—science—was and is considered of little account. Nelson's *Victory* is kept enshrined by the British Admiralty. H.M.S. *Beagle* —the survey vessel that sailed the world's oceans during the decade from 1826 to 1836 and bore Charles Darwin on his five-year circumnavigation of the globe—is gone.

My husband and I write and illustrate children's books in the field of natural history. Occasionally we give talks at the Connecticut schools near where we live. Some time ago, so that we might illustrate more vividly the epic
venture of Darwin's voyage on the *Beagle*, I bought a p
tic model of the American whaleship *Charles W. Mor*

Assembled, she is four inches long. Explaining to
audiences that the *Beagle* was somewhat like this ship
we voyage with Darwin and the *Morgan-Beagle*. With p
tic sails set, we head for Brazil, and then south along
coast of Argentina. We trail imaginary nets astern, catch
plankton; we see the water's phosphorescent glow.

In port, we leave the *Beagle* and board a horse. V
Darwin and the Gauchos we gallop the pampas. We c
"ostriches" (rheas) with a bolas. We note that Dar
learned to handle the bolas the hard way—by entang
his own horse's hind legs while the Gauchos laughed.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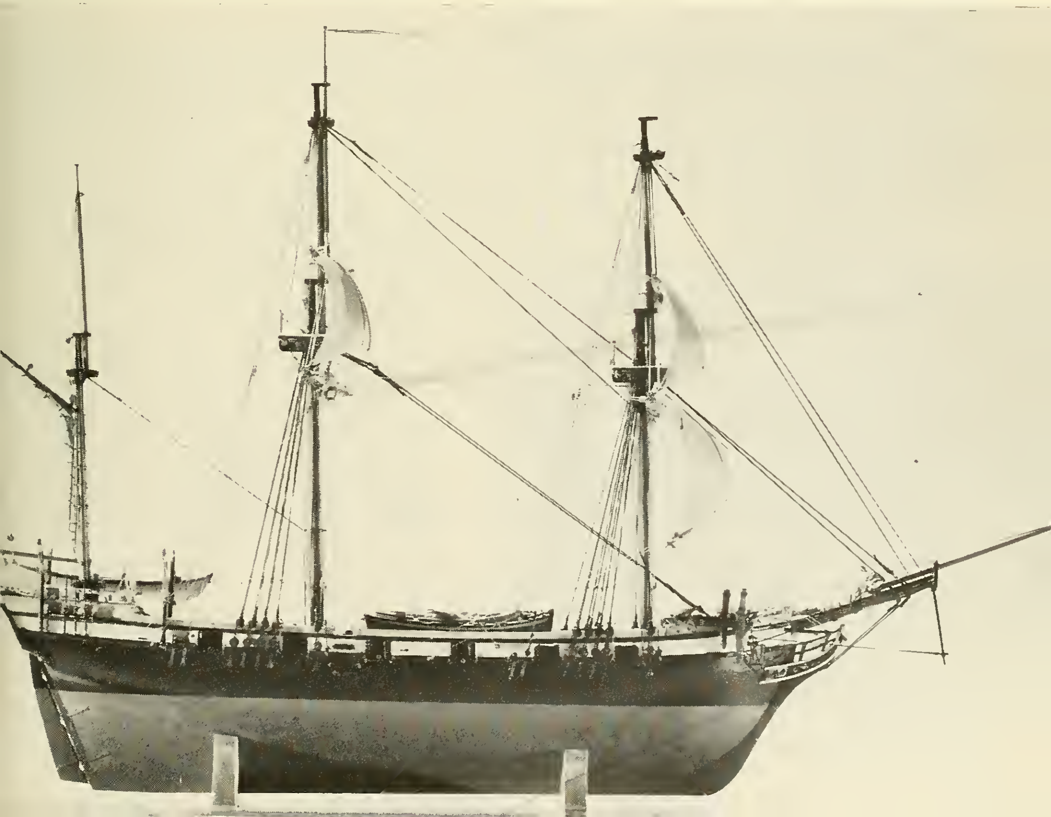
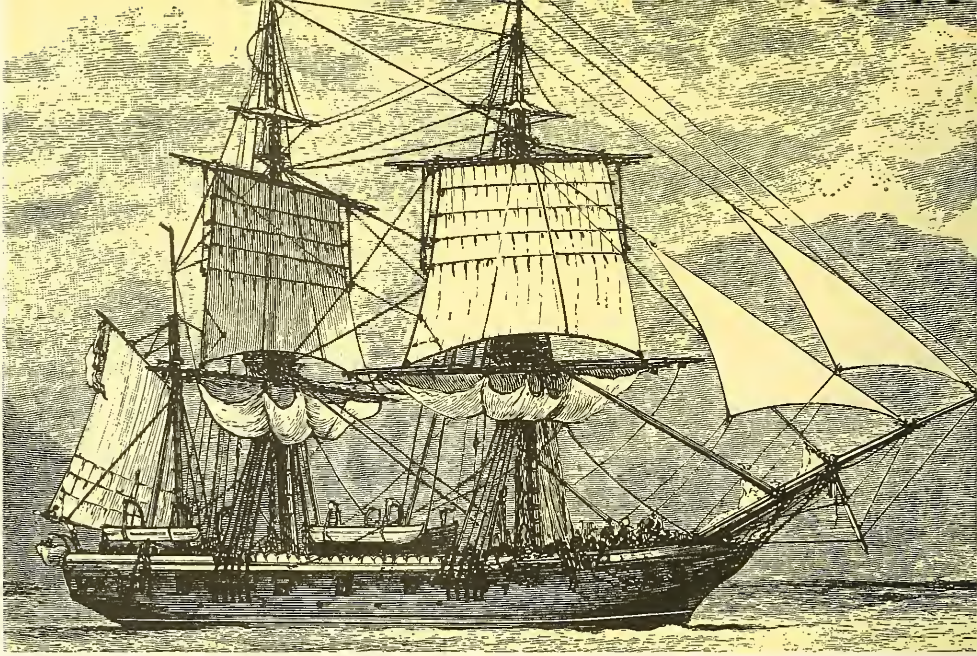
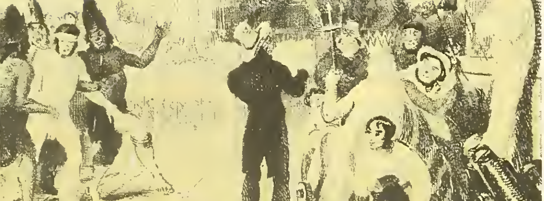
ZENMAST'S POSITION is seen, *below*, on model of *Beagle* lt by the author on the basis of the research recounted in her article. Scale of model is three thirty-seconds of an inch to one foot: thus, the hull length is nine inches.





Pritchett's drawing of the *Beagle* has long been th
authentic. Actually, sketch includes a number of mis

Back aboard the *Beagle* once more, we head toward Cape Horn. Buffeted by high winds and great seas, we sail the forbidding Fuegian coast and explore its dark forests and high mountains. Then we scud free into the Pacific. In Chile, we experience an earthquake and see land newly risen from the sea. We find fossil sea shells high in the Andes; study Galápagos lizards, tortoises, and finches; visit South Sea islands and speculate upon the causes of coral atolls. We attempt to share with the children Darwin's delight in all he found and saw. With the help of the *Morgan-Beagle*, we try to make his great adventure come



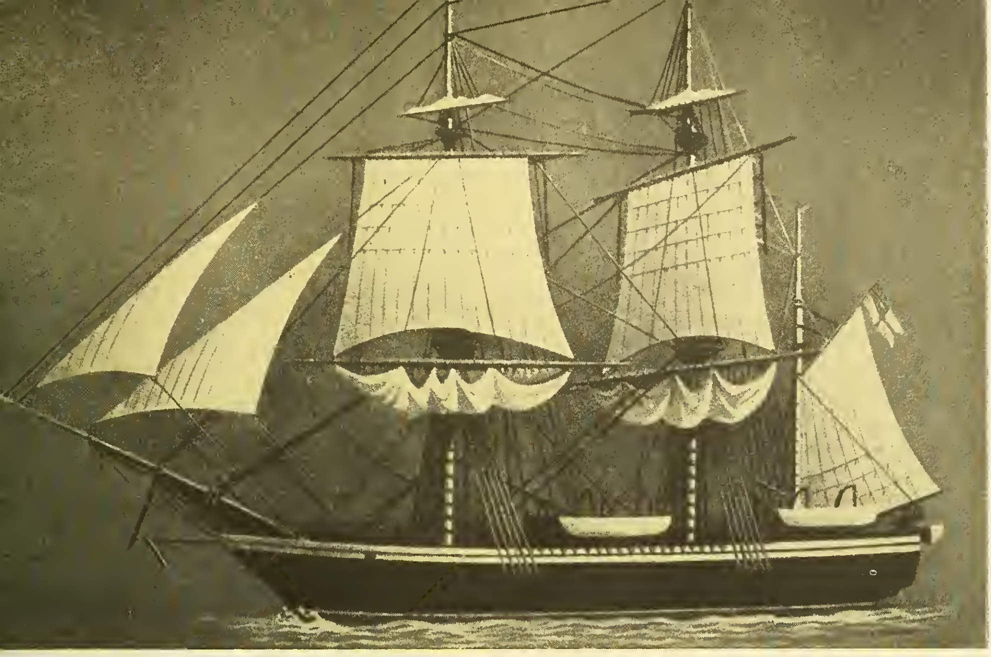
Crossing the line in 1832, ship's artist Earle recorded this scene of traditional merrymaking on board the *Beagle.*

But what was H.M.S. *Beagle* really like? In his ac
of the voyage, Darwin scarcely mentions the ship. Alth
he did describe the *Beagle*, and her officers, in letters
family, there is nothing very concrete in these descri
—only bits and snatches, here and there. For examp
September 19, 1831, on first seeing the ship, he wro
cousin W. D. Fox: "My objection to the vessel is its
ness, which cramps one so for room for packing my
body and all my cases. . . . As to its safety, I hop
Admiralty are the best judges; to a landsman's ey
looks very small. She is a ten-gun three-masted brig,
believe, an excellent vessel."

So the puzzle starts. For, if a brig has three mast
is *not* a brig! Brigs have but two masts, with s
sails on each. Darwin should have known what he was
to embark in, however much a "landsman." Yet he wa
calling the *Beagle* a brig when his account of the v
was first published in 1839.

For years I have come upon the same old print—w
published in books and newspapers—which I have
to be an authentic portrait of the *Beagle*, done by o
the artists aboard during her celebrated voyages. This
shows her with three masts, right enough: therefore,
cally, *not* a brig. If all three masts had carried square
H.M.S. *Beagle* would have been a true *ship*, in the tec
sense of the word. But the third mast shows fore-a
sails only. The *Beagle*, then, was a bark, not a brig.
did Darwin persist in calling a brig a vessel that w
viously rigged as a bark?

My curiosity slowly began to take the form of a
I decided to make an authentic model to replace our



IVERSARY PORTRAIT of the *Beagle*, painted for a *Life* le, evidences an indebtedness to Pritchett, *opposite.*

gan-Beagle*. There would doubtless be plans. authentic vings, or a fine model of the *Beagle* somewhere. I would e to the British Admiralty.

tiny note, written in a spidery hand, came in prompt ver to my letter:

Dear Madam. In reply to your letter of the fourth ch about H.M. Ship 'Beagle,' I write to say that such s and drawings of H.M. Ships of that period as now t are deposited in the National Maritime Museum.

you write the Director. National Maritime Museum, nwich, London, S.E. 10, he will inform you as to the nt to which your requirements can be satisfied.

ours faithfully, Deputy Librarian."

wrote forthwith as the Deputy Librarian suggested. e are some extracts from the reply:

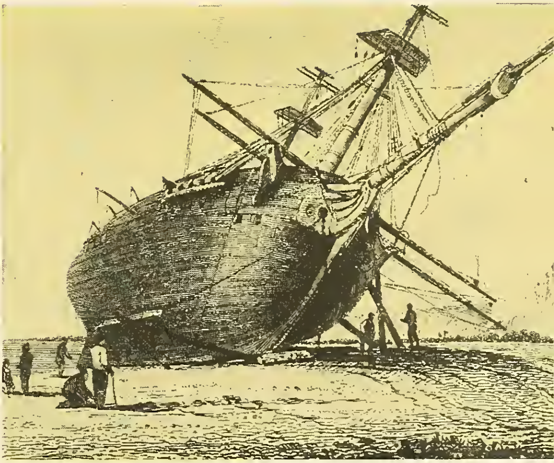
With regard to the 'Beagle,' we have the Admiralty s for the class of 10 gun brig to which the 'Beagle' be- ed. These do not show the ship as fitted for Darwin's ıge, but they give the shape of the hull which was not ny way altered. Unfortunately no rigging plan exists. ough the 'Beagle' was a brig, a small third mast was ied in order to assist with steering. This was also fitted everal other types of brig at this time and we have illus- ons showing the sail plan with the three masts, in her class of brig.

will send you copies of four of our plans and I think should be able to get sufficient information to make a onably accurate model of the 'Beagle.'

. A. H. Waite, Deputy Curator of Models and Relics."

was lucky that my letter had found its way into Mr. te's able and co-operative hands. The brig-bark prob- which he cleared up in such short order. was only the of many that he was later able to solve. In due time, photostats of the beautiful old Admiralty drawings arrived (three details are reproduced here). I began to realize that the search for the *Beagle* was only beginning. Exactly how was she fitted for Darwin's voyage? What changes. other than the addition of a mizzenmast. had been made? The true *Beagle* was becoming a mystery. If I were to find out how she really looked. I would have to do my own research.

One of Loren Eisley's splendid articles in *Scientific American* contains two sketches by P. G. King. showing details of the *Beagle.* But exactly who was King? Had he



BEACHED FOR REPAIRS, the *Beagle* was sketched by another ship's artist. Martens. Absence of figurehead is evident.

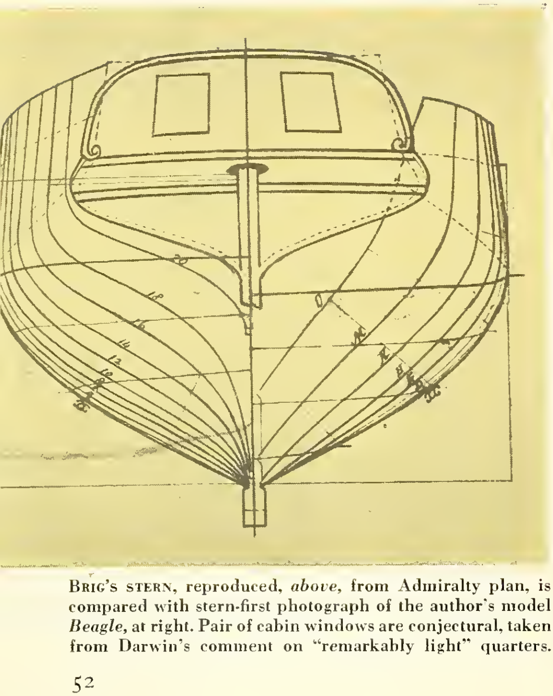
Mrs. Darling, a frequent collaborator with her husband in the writing and illustration of books in the field of the natural sciences, is an old salt at heart and onetime U.S. Women's National Sailing Champion. Her model of the *Beagle* has been displayed at The American Museum.

done other sketches of the *Beagle* and, if so, when? I would have to find out. Library work was in order.

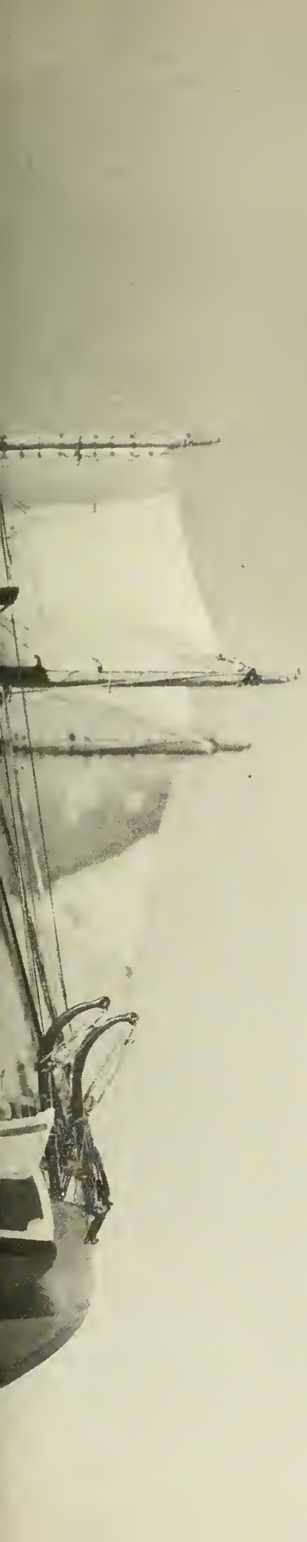
I first tracked down the *Beagle* that I had seen so often before (see page 50). *The New York Times* had printed it: a *Life* artist had copied his *Beagle* from it, reversed, in that magazine's memorial series on Darwin. The original print shows a canoe with four Fuegians in the foreground: the impression is that the drawing had been done on the spot by one of the *Beagle*'s own artists.

But such is not the case. The print proved on investigation to be one of many done especially for an illustrated edition of Darwin's *Voyage of the Beagle*, published by John Murray in 1890. It was used for the frontispiece: opposite it, on the title page, is another view of the *Beagle*, stern on (see page 54). In his introduction, Murray says: "Most of the views given in this work are from sketches made on the spot by Mr. Pritchett, with Mr. Darwin's book by his side." This statement is ambiguous at best.

Robert Taylor Pritchett (1828-1907) was a well-known illustrator. It is possible that Pritchett *could* have drawn his "view" (in this case, Mount Sarmiento in Tierra del Fuego) "on the spot." But the *Beagle*, the subject of his picture, had upped anchor and left "the spot" fifty-six years before, while the artist was only six years old! Had he known that his sketch would become very nearly the defini-



Brig's stern, reproduced, *above*, from Admiralty plan, is compared with stern-first photograph of the author's model *Beagle*, at right. Pair of cabin windows are conjectural, taken from Darwin's comment on "remarkably light" quarters.



tive representation of the *Beagle*, I think Pritchett might have taken more pains. In his drawing, the lovely hull—which the Admiralty drawings show so well—is made gross. The position of the masts is wrong. Waist davits are placed as they were on whalers, while the boat hanging from them is not only an unseaworthy type but too small, scaling only some seventeen feet in length. The boat on the quarter davits is equally unseaworthy and even smaller—about fifteen feet in length.

Nor are these the only faults to be found with this traditional *Beagle* picture. In his narrative of the voyage, Captain Fitzroy mentions that twenty-five-foot whaleboats hung from the *Beagle*'s quarter davits, while two twenty-eight-foot whaleboats, when not in use, were carried upon skids over the quarter-deck. The *Beagle*'s largest boat, her yawl, was carried amidships. The cutter was nested in it, to save space. There simply were *no* waist davits.

Again, the gunports and portholes shown in Pritchett's drawing, aside from being out of scale, are not as they are shown in the Admiralty profile of a brig of this class. Although she carried seventy-four persons, the *Beagle* was a jaunty *little* ship—scarcely one hundred feet long. Finally, in Pritchett's stern view of the *Beagle*, lofty royal sails, as well as studding sails, are set. The ship *did* set studding sails occasionally, as Fitzroy's account attests. But all the evidence suggests that her rig was too reduced to permit the carrying of royals.

So much, then, for Pritchett's ex post facto study. What about King's sketches? King, I learned, had been a midshipman aboard the *Beagle* when she set forth on her momentous voyage two days after Christmas in 1831 (December 26 had been spent in sobering-up the seamen). He was the son of Admiral P. Parker King who, as captain, had been in command of the first expedition of *Adventure* and *Beagle*, 1826-1830. On the second expedition, young King had accompanied Darwin on many a trip ashore. In one letter, Darwin says, "... he [King] is the most perfect pleasant boy I ever met with, and is my chief companion."

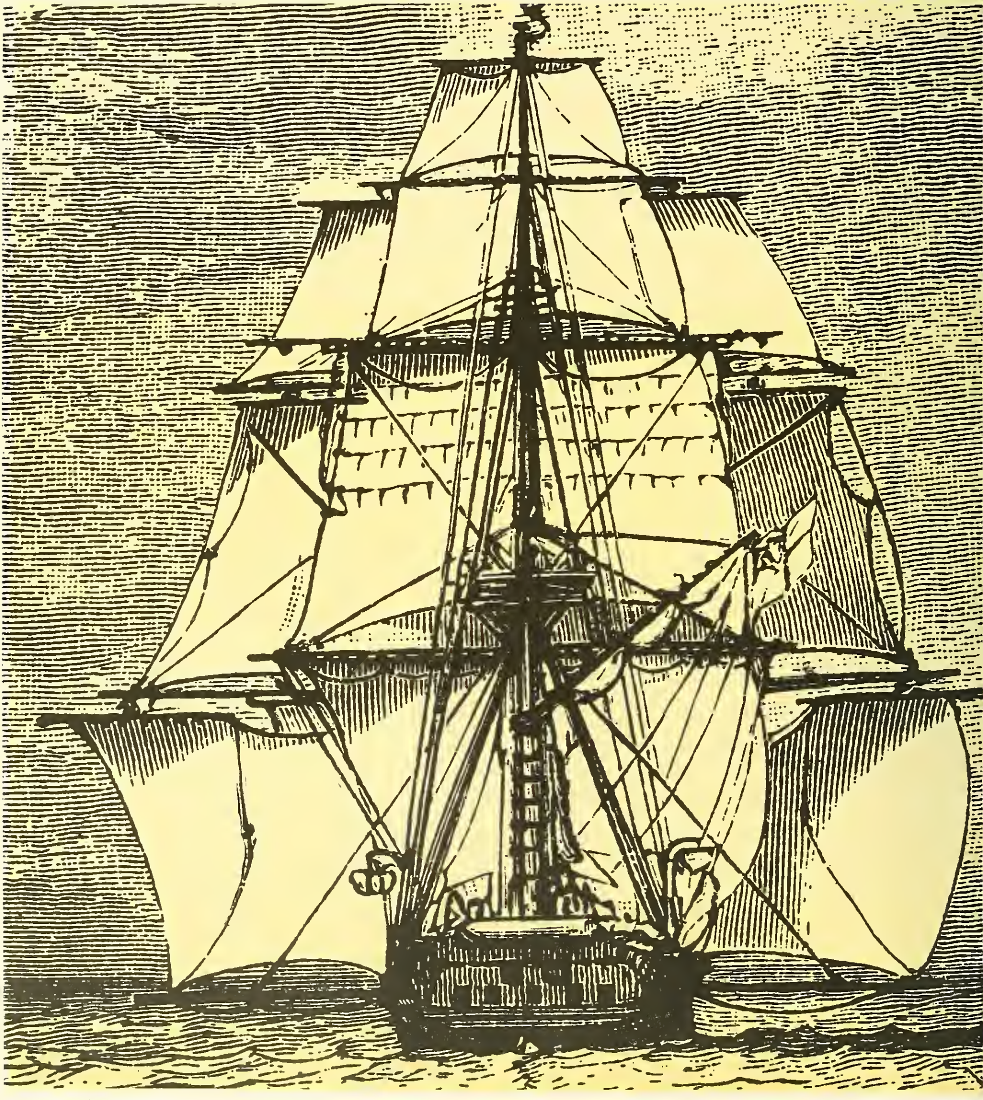
About 1890, when he was close to eighty, King prepared his sketches of the *Beagle* at the request of Mr. Hallam Murray. These sketches were then used in several editions of the *Voyage*, without acknowledgment. In a letter of 1897, King says that he had done the sketches from "old drawings and recollections." To what old drawings he referred I do not know. I *do* know that the old gentleman's sketches from memory check remarkably with the Admiralty drawings. King, incidentally, shows the yawl stowed amidships.

Some later editions of the *Voyage* either use King's sketches, or elaborate copies of them. In various of these copies, the *Beagle*'s figurehead—drawn obscurely by King in his simple profile, has somehow evolved into an actual representation of the front half of a beagle. I have an etching of "The *Wolf*, Brig of War," done in 1829. *Wolf* shows a wolf for a figurehead, so it is not beyond possibility that the *Beagle* had a beagle. But, as we shall see, this romantic detail is suspect, to say the least.

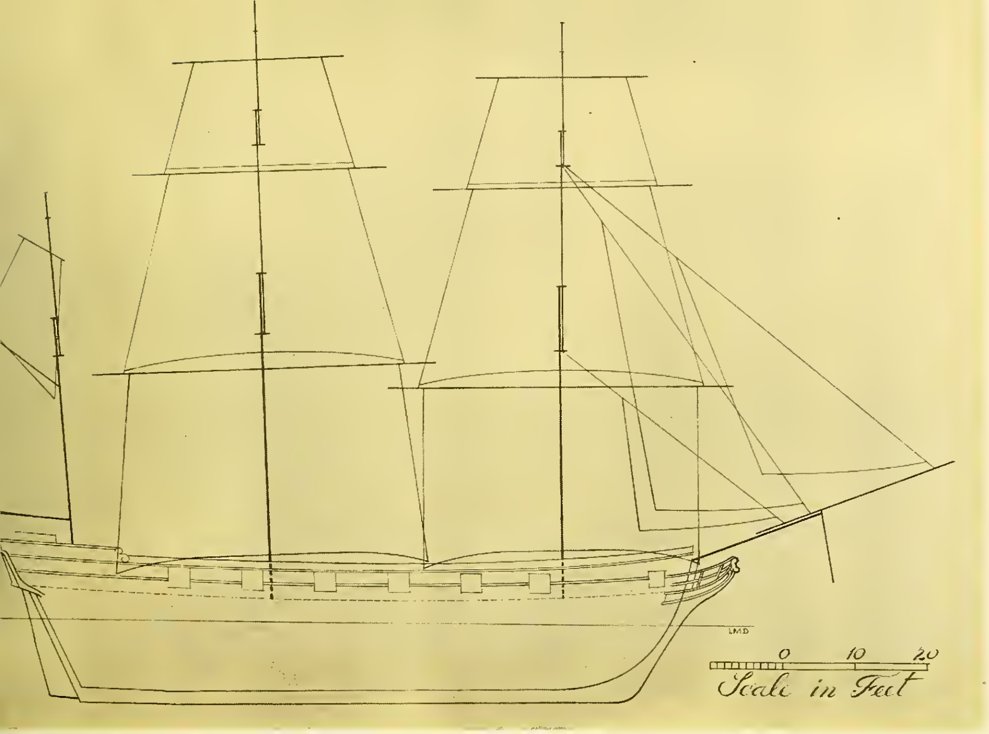
When the *Beagle* sailed on her second voyage, Augustus Earle was aboard as ship's artist and draftsman. In a published sketch, he shows *Beagle*'s deck as she crossed the Equator in 1832. Mainly, the scene depicts rollicking sailors (see page 50). But, in the foreground, the main skylight is seen and a cannon points forward along the starboard bulwarks. Here were more welcome details.

In August, 1832, Earle was replaced by C. Martens, who remained as the *Beagle*'s artist for the next two years. Many of the beautiful steel engravings that illustrate the 1839 Colburn edition of *The Surveying Voyages* are from Martens' sketches and gentle water colors. Unfortunately, most of Martens' drawings show the *Beagle* and her small boats as unimportant parts of the general landscape. A magnifying glass helps a little, but the only detailed drawing that Martens made of the *Beagle* shows her laid ashore for repairs (see page 51). Here, the bow shows a simple billet head, or scroll, carved under the bowsprit. It seems reasonable that Martens would have copied such an obvious thing as a carved figurehead had it existed. But he s neither man, maid, beast, nor beagle, rampant or other

Between visits to various libraries in my search fo *Beagle*, I sought help from Gordon Grant, marine and model-maker extraordinary. I have known him since I was a child, when his famous painting of U *Constitution* first sailed across my youthful horizon. Grant has sailed on square-riggers. Although now i eighties and nearly blind, he was no end of help. He lo me *The Young Sea Officers Sheet Anchor, or a Key t Leading of Rigging, and to Practical Seamanship,* by D Lever (the second edition, published in London in 18



Pritchett's conception of the *Beagle* under full sail is also a plate from the 1890 edition of Darwin's *Voyage.* Topmost sail shown on mainmast, the royal, is a produ artist's imagination, as are seven gun ports across s



ONSTRUCTION of the *Beagle*'s sail plan, *above,* derives art from Admiralty plan for mizzenmast-fitted brig of another class. Other sources of information include sketch made by the mate of the *Adventure* on the previous voyage.

e was a gold mine of information: in it, rigging details commonly in use when the *Beagle* was built were ıtely illustrated and described.

Y own library holds a copy of *Plates of Shipping and Craft,* by E. W. Cooke, printed in London in 1829. ke's delightful old etchings now proved to be a help, ed. The date was exactly right. As a further aid, Mr. te of the National Maritime Museum had sent photo- hs of their nearest model to the *Beagle.* This model is ed as a brig and has no poop cabin, but her lines are bviously similar to those of the *Beagle*'s class that de- of hull and rigging alike were helpful.

aving thus gleaned what pictorial help I could find. I ed reading. What better source than the earliest avail- edition of the basic work, with its imposing title: *Nar- e of the Surveying Voyages of His Majestys Ships enture and Beagle between the years 1826 and 1836, ribing their Examination of the Southern Shores of h America and the Beagle's Circumnavigation of the e.* Volume I is entitled *Proceedings of the First Expedi- , 1826-1830, under the Command of Captain P. Palmer g, R.N., F.R.S.* Volume II is a further account: *Proceed- of the Second Expedition, 1831-1836 under the Com- d of Captain Robert Fitz-Roy, R.N.* Volume III is win's first published book, entitled simply *Journal and arks 1832-1836.* It is this third volume, with various ges and after many editions, that has come to be known e *Voyage of the Beagle.*

"Fitz-Roy's character," Darwin writes, "was a singular one, with many noble features, he was devoted to his duty, generous to a fault, bold and determined and indomitably energetic. . . ." Obviously his seamanship must have been superb. He suffered from terrible fits of depression and a vicious temper. He was also compassionate and very religious. One of the reasons Fitzroy wanted a naturalist aboard was to help in eventually proving the literal truth of the Bible. In Volume I (January 1830) he gives another reason. "It is a pity that so good an opportunity of ascertaining the nature of rocks and earth of these [Tierra del Fuego] regions should have been lost.

"I could not avoid often thinking of the talent and experience required for such scientific researches, of which we were wholly destitute; and inwardly resolving, that if ever I left England again . . . I would endeavor to carry out a person qualified to examine the land; while the officers and myself would attend to hydrography."

Captain (later Vice Admiral) Fitzroy's intense, sensitive temperament shines through his writings. Forming a picture of the *Beagle* from his words became like piecing together a jigsaw puzzle—but far more engrossing—with the many parts in this case scattered tantalizingly through a lengthy volume. Captain King's earlier expedition, also, could not be neglected. If this account of my search seems now to grow disjointed, that is how I found it, too. The first and second voyages swim together unavoidably.

In Volume II, Captain Fitzroy states: "The *Beagle* was commissioned [actually, recommissioned] on the 4th of

July, 1831, and was immediately taken into dock to be thoroughly examined, and prepared for a long period of foreign service. As she required a new deck, and a good deal of repair about the upper works, I obtained permission to have the upper-deck raised considerably, (eight inches abaft and twelve inches forward) which afterwards proved to be of the greatest advantage to her as a sea boat, besides adding so materially to the comfort of all on board.

"While in dock," Fitzroy continues, "a sheathing of two inch fir plank was nailed on the vessel's bottom, over which was a coating of felt, and then new copper. This sheathing added about fifteen tons to her displacement, and nearly seven to her actual measurement. Therefore, instead of 235 tons, she might be considered about 242 tons burthen . . . a patent windlass supplied the place of a capstan . . . and the lightning conductors, invented by Mr. Harris, were fixed in all masts, the bowsprit, and even in the flying jib-boom [these were to be tested]. The arrangements made in the fittings, both inside and outside, by the officers of the Dock-yard, left nothing to be desired. Our ropes, sails, and spars, were the best that could be procured; and to complete our excellent outfit, six superior boats (besides a dinghy carried astern) were built expressly for us, and so . . . stowed that they could all be carried in any weather.

"Considering the limited disposable space in so very small a ship," Fitzroy adds, "we contrived to carry more instruments and books than one would readily suppose could be stowed away in dry and secure places; and in part of my own cabin twenty-two chronometers essential equipment for surveying voyages were carefully placed."

I learned in my reading that the Beagle carried only six of her normal complement of ten guns: these were long six pounders and long nine pounders of brass. Here are some more notes, taken at random from Fitzroy's narrative. Each offered some clue in my search. "At three in the morning of the 13th [January 1833]," he wrote, "the vessel lurched so deeply, and the main-mast bent and quivered so much, that I reluctantly took in the main-topsail (small as it was when close reefed), leaving set only the storm-trysails (close reefed) and fore-staysail. At ten, there was so continued and heavy a rush of wind, that even the diminutive trysails oppressed the vessel too much, and they were still farther reduced.

"Soon after one," he continued, "the sea had risen to a great height, and I was anxiously watching the successive waves, when three huge rollers approached, whose size and steepness at once told me that our sea-boat, good as she was, would be sorely tried. Having steerage way, the vessel met and rose over the first unharmed, but, of course, her way was checked; the second deadened her way completely, throwing her off the wind; and the third great sea, taking her right a-beam, turned her so far over, that all the lee bulwark, from cat-head to the stern davit, was two or three feet under water. For a moment, our position was critical; but, like a cask, she rolled back again, though with some feet of water over the whole deck. Had another sea then struck her, the little ship might have been numbered among the many of her class which have disappeared: but the crisis was past—she shook the sea off her through the ports, and was none the worse—excepting the loss of a lee-quarter boat, which although carried three feet higher than in the former voyage (1826-1830), was dipped under water, and torn away. It was well that our hatchways were thoroughly

Poop deck and wheel area of model *Beagle*, shown, *al*
in close-up, derived many of their details from the sk

secured, and that nothing heavy could break adrift.
little water found its way to the lower deck, though
Darwin's collections, in the poop and forecastle cabin
deck, were much injured."

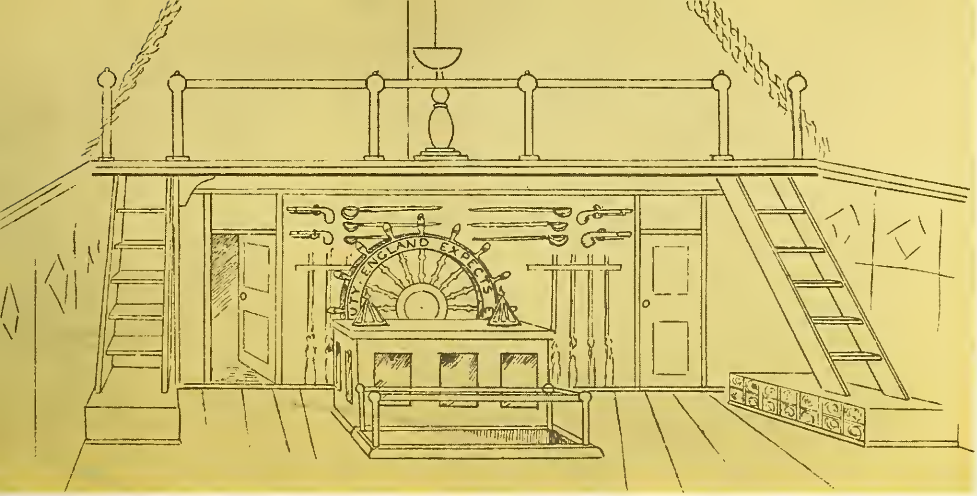
The *Beagle*'s yawl is described. "She was a beau
boat, twenty-eight feet in length . . . pulled and sailed
and was roomy, light, and buoyant. . . ." I learned tha
Beagle's boats ". . . did not hang idly at their davits. .
being sometimes gone a month and more, exploring i
and rock-strewn channels. Fitzroy tells of one of the b
being stolen by the Fuegians, of a fruitless search, an
how, finally, ship's carpenter Jonathan May and three
were set on that wild and lonely shore to build a new b
This they accomplished in twenty days. I had hoped to
the building of the replacement described. Alas, no-
mundane an affair, I suppose.

The *Beagle*'s many anchors are mentioned and her
choring losses and problems discussed. ". . . we n
one good anchor out of two broken ones. . . ." Fitzroy
lates. He had no sooner turned in, one midnight, wh
link on an anchor chain parted at the hawse hole.
Fitzroy attributed ". . . to the action of frost. . . ." Da
mentions losing four anchors within three weeks, lea
only one good bower!

"The bearing compass," Fitzroy notes, "though part
larly good, and well placed, was of very little use—n
trusted in important bearings." This is undoubtedly
compass that King's sketch shows on the quarter d

Fitzroy describes the *Beagle*'s call at Otaheite (Tah
Anticipating a visit from the Queen of Tahiti, Fit
says, "We tried to make such preparations as our l
vessel could accomplish. Dressing the ship with flags
salute [with cannon] we could not, on account of
chronometers [jarring them would be serious]."
". . . the seamen manned the yards, and we all gave
Queen three cheers.

"The work necessary for securing the ship being c
pleted, permission was given to admit the natives, and



. G. King, a midshipman at the time of the voyage, from memory about 1890, *above*. Fitzroy's account speaks of the theft of one of the many brass knobs shown. Ratlines will be added to the model's shrouds at a later date.

they swarmed like bees. In a minute. our deck be- a crowded and noisy bazaar." One Tahitian, Fitzroy "absconded with the top of a brass stanchion." I was ie had, for Fitzroy's mention of the stanchion helped m King's drawing that shows them.

the second of October, 1836, the *Beagle* dropped an- it Falmouth. Fitzroy ends his narrative, ". . . and it is ps remarkable, that while the *Beagle* was in commis- between February 1829 and November 1836. no is illness, brought on or contracted while on service, ned on board; neither did any accident of conse- e occur in the ship. nor did any man ever fall over- during all that time."

ere were, of course, many more insights to be gleaned these accounts. Fortunately, the results of all the dif- lines of research fell together remarkably well. Once d, the model seemed to make itself.

Beagle's class of ten gun brigs was anything but tub- their husky, seaworthy lines are beautiful. Shaping roportioning the model's poop cabin and the fore- was not difficult: there was little choice if I kept to ferences. Darwin wrote that his poop cabin was "a l one, certainly next best to the Captain's and re- ibly light." The Admiralty drawings show two gun- in the transom but, for ordinary purposes, stern cannon would be out of place in Darwin's cabin! It logical to suppose that, when the *Beagle*'s poop cabin dded, the former gunports were simply transformed tern windows. Otherwise, the only light in that "re- ibly light" cabin would have come through the sky- on the poop deck and through the doors kept open weather permitted. Two of King's sketches show a ry" across the stern in the poop cabin. This is per- g, as it makes these stern windows uncertain. Shelves have been built around the windows, however, so that indows, themselves, would not necessarily be evident ner a plan or a profile view.

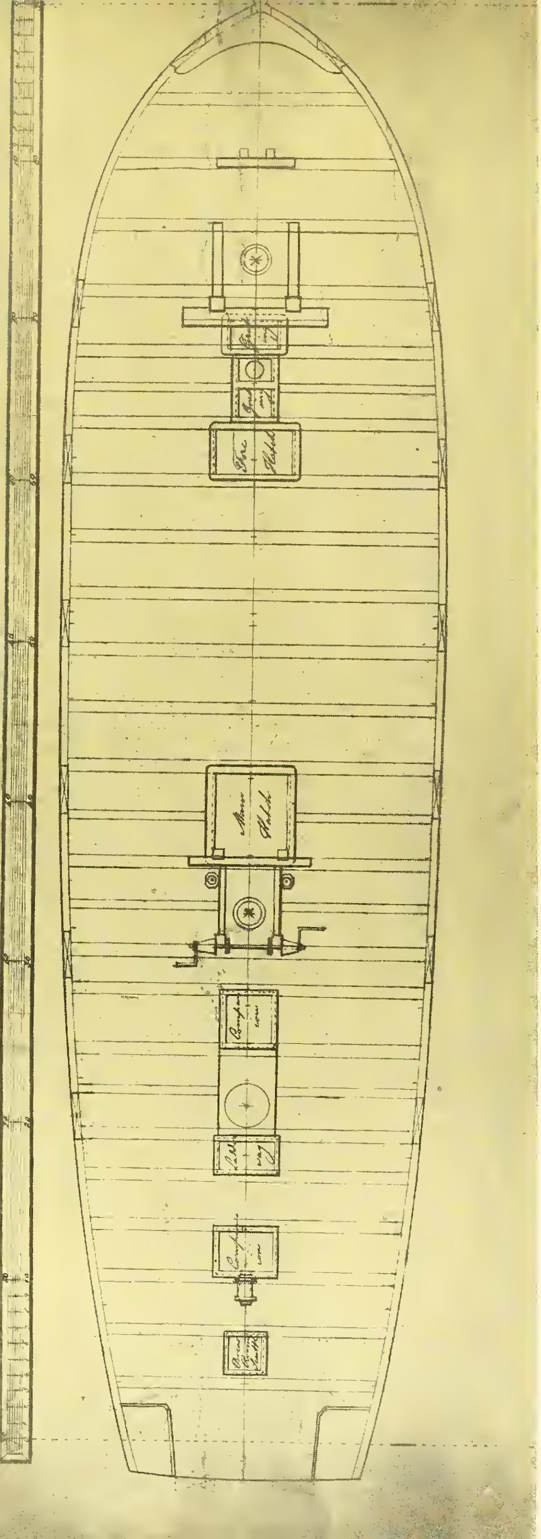
to armament in general. just before the start of the e's second voyage, Captain (later Admiral) Sir Francis Beaufort—the famed hydrographer, whose wind scale text sings like pure poetry—wrote a long memorandum to Fitzroy outlining the voyage's aims. This memorandum ends with an admonition against the use of violence: ". . . for it would be a subject of deep regret that an expedition devoted to the noblest purpose, the acquisition of knowledge, should be stained by a single act of hostility." To show the *Beagle*'s already reduced complement of cannon bristling from her gunports would hardly have been in keeping with Beaufort's high purpose. Thus, in the model, I have shown but one cannon on deck, assuming that the rest were usually stored below, out of the way and dry.

Darwin describes the *Beagle*'s Lieutenant, John C. Wickham as a "glorious fellow." But, being responsible for the shipshape order of his vessel, Wickham was somewhat reserved. He objected to Darwin's scientific litter about the decks, spoke of specimens brought aboard as "d-d beastly devilment" and told Darwin, "If I were skipper, I would soon have you and all your d-d mess out of the place." At the foot of the port ladder to the poop deck. therefore. I have scattered some of Darwin's "mess"—barrels, tubs, and boxes. with silent apology to Wickham.

The *Beagle* flew a common commissioning pennant from the top of her mainmast. This bore Saint George's Cross and a tail of red, white, and blue. Its length would have been almost thirty feet (see illustration, page 59).

As to the ship's name. I quote Mr. Waite again: "Strangely enough. names of war ships were not shown at all. There was a period in the 1770's when they were painted in large letters across the stern. but this only lasted for about seven years. In later years, their names were exhibited on the deckhouse aft, but only merchant ships had their names prominently displayed on the transom. . . . It is often shown erroneously in pictures or on models. Rather disappointing, I fear, but there it is." On Mr. Waite's advice, therefore, I left the model's transom nameless.

Recently, I happened upon a plan view of the *Beagle*'s deck in a Murray 1902 edition of the *Voyage* I had previously missed. No source for this drawing is giver since I know that the profile view shown on the same is taken from King, the plan view, in all likelihood, i from a sketch of his. This drawing checks with th miralty plans in most details, as well as with Fitzroy scriptions. The position of the quarter davits—not indi on the Admiralty plans—is farther forward than I p them on the model, and the exact position of the deck for carrying the whaleboats is also shown. The mod seen in these photographs may have to be changed a jibe with this new-found information.



I tried to make the model *Beagle* come alive by pa ing her after another quotation from Captain Fi "At midnight," he wrote, after months of exploration Strait of Magellan, "we were in the Pacific, and al anxiety about weeks of beating to windward upon allowance of provisions, vanished as quickly as the astern. The glass falling, with the wind astern in th quarter, foretold unusually bad weather; we the shortened sail by degrees, making all secure. At six o' in the morning, it was blowing a gale of wind, with so sea, that it was necessary to steer right before it—or to—which with a fair wind was not preferable: *an found the vessel scud extremely well, under close r fore and main topsails, and double reefed foresail.*"

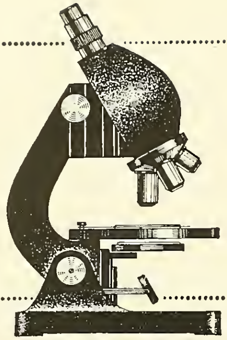
This is the canvas the model carries. "Close reefe sails" means that the topsails were reefed as much a sible. The *Beagle*'s topsails carried five rows of reef p if the final row was used, the sails were reduced t their maximum size. The topsail yards were lowere cordingly. Since the topsails were sheeted to the yards, these did not generally move up and down.

Lower sails commonly had only two rows of reef p the foresail was thus double reefed "up" to the stati yard. This raised the sail away from grasping, win seas. When the weather caused sails to be much r Fitzroy mentions, topgallant masts and yards wer quently on deck. The model shows this. But I left the topgallant mast housed (slid down along the main mast) so that the vessel's pennant streams before the

I did not want to show the *Beagle* under a cloud of s canvas. She was a hard-working, beat-about little bri ing her job under almost impossible conditions: i whole five years Darwin was aboard, she never had a yard overhaul. Her sails must have been worn, patche mildewed: in any case, I have shown them so.

The fact that the *Beagle* was such a no-account, aday brig—one of many in her class—is the reason, I t that accurate descriptions and pictures of her are so s These "coffin brigs" were frequently lost at sea; not sarily because of fault in ship or crew, but because so of them were engaged on a variety of dangerous mis In the British Navy during those halcyon days, n thought that there would not always be such brigs at s that men would not always voyage in this fashion. An dently, no one dreamed that the *Beagle* would be imp enough to be worth depicting exactly until it was too

ADMIRALTY DECK PLAN for a brig of *Beagle*'s class, *le* compared with photo, *right*. The cutter, one of the six the *Beagle* carried, is amidships, nested inside the The model is seen reefed down, scudding before the



NATURE AND THE MICROSCOPE

By JULIAN D. CORRINGTON

Dr. Corrington's column appeared regularly in Nature Magazine for nearly twenty years, and can now be followed in the combined magazines.

We are beginning this second installment in our new series on the microscope with a query that appears simple on the surface, but which raises many interesting questions. Most people would say that a microscope is an instrument that can provide a magnified view of an object, and if you should ask for a definition of magnification they would reply that it involved an increase in size—a view showing the object larger than natural size. All of this is true, but it brings up still another inquiry: what is the "natural size" of any object?

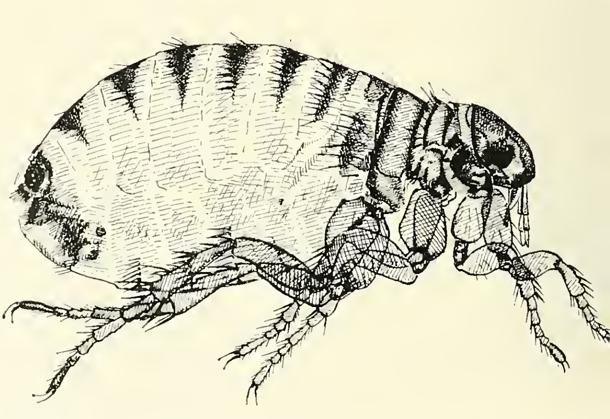
Our impressions of size are relative: they depend entirely on how close the observer is to the object. To a cat, for example, any object considerably larger than itself, such as a horse, would be "big," another cat would be "normal size," and a mouse would be "small." To the mouse the cat is "large," often unfortunately so. Man has been compelled to invent arbitrary units of measurement, such as the foot or meter or mile, in order to express concepts of size and distance exactly. So how are we to judge when an object is magnified or not? As children we think the full moon is about the size of a dinner plate, not being able to comprehend great distances or dimensions. As adults, we can hold a dime in front of one eye and thereby block out the full moon completely, but we do not as a consequence believe that the moon is only as big around as the dime.

With the invention of optical instruments, the importance of establishing standards became apparent, for the microscope had to be designed to deliver an image of some selected size at some definite distance. It was determined from many measurements that the average person, when he reads or scrutinizes something in the hand, holds the book or object ten inches from his eyes. This distance was then designated the *near point*. After adoption of the metric system in all scientific work, this arbitrary determination became 250 mm. The corresponding *far point* lies at infinity.

By definition, then, the "natural size" of any small object is that that we observe when it is held 250 mm. from the eyes. Most people can still discern the printed page clearly when it is brought to within six inches of the eye, but as the print is carried closer and closer there comes a point at which the letters blur and we can no longer see them distinctly. We behold them enlarged (that is, magnified) but obscured. Try this on your own vision, using a ruler.

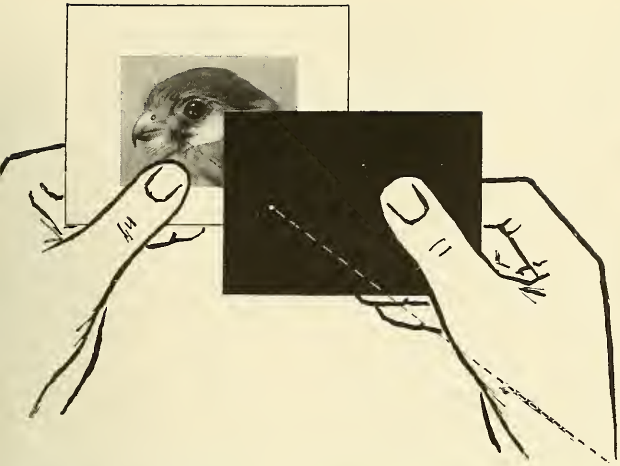
According to this interpretation, any view of an object closer than the near point is a magnified one. If you take a piece of black photomount paper the size of a postcard and puncture it with a pin in the center of the width and one inch from one of the ends, you will have made the world's simplest microscope, the *pinhole card*. A postcard will do, but stiff black paper is better. On a second card, paste a photograph cut from a newspaper and examine this illustr
through the pinhole card, holdin
pinhole as closely as possible to on
Bring the picture up to the pinhole,
ing from six inches away, and see
can get it within about one inch of
eye and still note detail clearly. I
can, you have secured a magnificat
ten times, abbreviated in microsco
10X, a very respectable enlarge
This is simply the ratio of the near
distance of ten inches to the one inc
tance at which you are viewing th
ture. You will also see the hal
screen, described in our previous in
ment, and observe that the illustr
is no more than a collection of d
various shades of light and dark.
have actually magnified your view
photograph ten times with only a
of cardboard. Our first definition of
nification is that it consists in g
the eye closer to the work, so th
can see it clearly at any distance t
less than the 250 mm. near point.

Seneca, the Roman philosopher
died in A.D. 65, wrote about the
ous circumstance of looking thro
tumbler of water at a bowl of appl
his dining table. Most of us have
this experience in one form or an
and have observed that the object
magnified and distorted. Had Senec
lowed up his observation, he might
discovered that curved surfaces of
parent materials refract or bend
rays that pass through them, and
this property of *refraction* can pr
enlarged images. He might even
gone on from this to invent spect
but Seneca was a philosopher and
experimental scientist. His tumbl
water was a crude microscope of
and we can make a better one by



This drawing of a mounted human flea shows correct positioning of the insect.

Legs are properly bent, each is v
mouth parts are easily distinguis



LE CARD makes a simple microscope. magnification can be obtained by holding black card close to the eye and adjusting the distance of viewed object.

of water hanging in a small metal contrived from a hairpin. The drop urved surfaces and will impart a magnification if a small object is d through it.

ny spectacle lenses are also micro- s, as any wearer can prove by look- printed matter with and then with- lasses astride his nose. A telescope optical instrument that employs the principles, with a different arrange- None of these articles is commonly ed to as a microscope, of course, e restrict the term to a single lens ombination of several lenses, held tal frames or tubes for convenience , and by means of which we can "bug's eye view" of some small t too small to be seen otherwise. other animals are as satisfactory icroscope material as are insects. are small enough to be mounted on a microscope slide. Indeed, and lice require such treatment if e to find out anything about their uction. Often we may wish some nation as to the architecture of bees etles or dragonflies, and many of are a bit too large, or at least too bodied, for slide mounting. How- the greatest interest concerning has to do with their external organs antennae, mouth parts, wings, and and these parts make wonderful cts for comparative studies of adap- and specialization. The expert also he male external genitalia as an aid ssification.

ce these are organic objects, un- he specimens of paper dealt with r previous installment, they need ional treatment, and the micros- t may take the next step in his ng by making numerous slides of insects and their parts. Ordinarily, in the microtechnique routine, living tissues must be *killed*; the term as used in this procedure refers to killing cells and tissues rather than to dispatching the whole organism. Then the objects must be *fixed*, meaning that they will be so preserved as to resist any decay. Inasmuch as any chemical reagent strong enough to fix will also kill, the two steps, though theoretically separate, become a single one in practice. The excess fixer must then be *washed* out, stopping fixation when completed, and next the specimen must be *dehydrated*. Water has to be removed for two principal reasons—to prevent maceration (a polite term for "rotting"), and to prepare the tissue for clearing in xylene and mounting in balsam or a synthetic mountant, neither of which will tolerate even a trace of water.

A good fixer does three things: it preserves, hardens, and produces optical differentiation by preparing unlike parts of the subject to take stains and to transmit light in varying degrees. This last is important if contrast of the parts is to be visible when viewed microscopically. Some fixers are mineral acids or their salts, such as mercuric chloride; some are organic acids, as picric; and the rough-and-ready ones are alcohol and formalin, time-honored reagents for gross preservation of whole animals or plants. The washing is usually done under running water, but a few fixers, as picric acid, require washing in alcohol. Dehydration is done with alcohol as a rule, though we shall describe some modern techniques using dioxan or Cellosolve at a later date.

It is important to note that the whole series of steps is one of *substitution*. We

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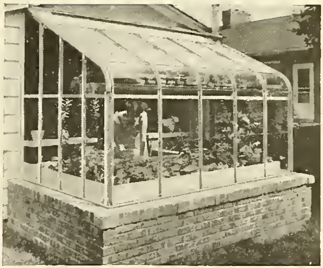

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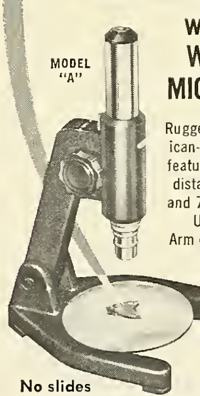

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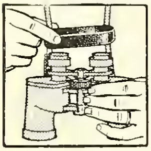

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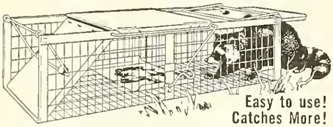

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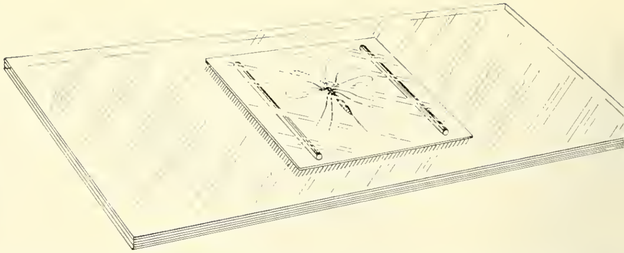


GLASS PROPS—in this case, thin glass rods drawn out under a flame—are used to keep the cover glass from crushin
insect ready for microscopic observa

replace natural body fluids with a fixer, the fixer with alcohol, the alcohol with xylene, and the xylene with mountant. The microscopist must always remember the correct sequence, based on miscibility (which is merely the technical term for "mixability"). Formalin is miscible with water but not with alcohol; xylene is miscible on the one hand with pure alcohol and on the other with balsam, but not with water. Staining mixtures, to be discussed in later columns, are made up as aqueous or as alcoholic solutions, and are inserted routinely, at appropriate places.

Now, in the case of insect parts we have things that differ from the usual organic material, for the insect wears his skeleton on the outside—it is called the exoskeleton—instead of inside—the endoskeleton—as do vertebrates. The material is also totally different, being chitin instead of cartilage or bone. Chitin is an organic secretion that hardens upon exposure, at the time an insect molts, and sets into a firm but elastic covering that prohibits any further growth until the next molt occurs.

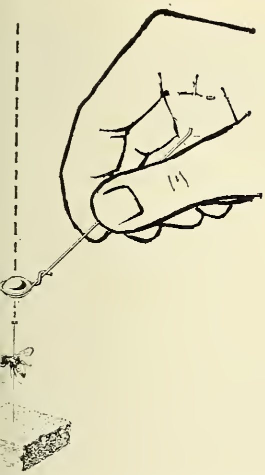
As a rule this exoskeleton is the part that is wanted for slide mounts. It requires fewer steps in the technique, and no staining. On the contrary, because it is usually darkly pigmented, it needs bleaching rather than staining. The soft inside organs may be dispensed with, and are destroyed and removed in one step, called *potashing*. This makes a flat mount so that even a thick-bodied insect, such as a bee, may be reduced to its exoskeleton and mounted whole. Here, too, we should list the basic classification of slide preparations—whole mounts, smears, and sections. An entire mounted object, whether a complete organism (flea, moss prothallium) or parts of organisms (beetle leg, portion of fern leaf), is described as a *whole mount* or *in toto mount*. *Smears* are actually whole mounts also, but consist of highly microscopic objects, as bacteria, diatoms, or blood cells. *Sections* are slices of organisms (such as an earthworm cross-section) or their parts (cat liver, basswood stem) cut to extreme thinness on a machine
microtome) so as to transmit light
on a slide, revealing anatomical de

PROCEDURE: obtain several dog o
fleas and put them either in a cya
insect-killing jar or in hot water f
few minutes. Then place them in o
the small aluminum dishes in w
many frozen items are packed t
(chicken pies, for example) or in th
of a baking powder can—any wort
and small metal receptacle—and
about one ounce of a 10 per cent sol
of potassium hydroxide upon them.
may be bought at a drugstore, or
may buy a stick of the solid and m
your own solution in tap water—one
solid, ten parts water. This potash
strong caustic and must be handled
the same care you would use wit
acid; avoid getting any on the han
clothing. Heat over a small and
flame, as from an alcohol lamp or a
sen burner turned low. Heat for fi
minutes, but do not boil. Transfe
fleas to a container of tap water to
for an hour or two. The swelling at
ant to the water absorption will c
the expulsion of some of the body tis

Try rolling a flea, gently and caref
from head to tail, with a round m
stick or small dowel or applicator s
The action is that of rolling dough w
rolling pin, but on a very much sm
scale. This should get rid of the
tissues without breaking off any o
appendages. Now repeat the p
treatment and the washing in wate
a second time, carrying the was
through several changes of water o
period of three or four hours, to ge
of all traces of potash. This treat
will also bleach the specimens fr
dark to a light golden brown. Do
carry the bleaching so far that the
become colorless. It is best to start
several fleas lest some be ruined
dentally in these manipulations.

Transfer these midget insects to
hol for fixing and dehydration. Colle
and industrial laboratories may o
pure ethyl (grain) alcohol tax fre
scientific purposes, but there are

ols, unfit for human consumption,
may be purchased without special
ses. The best for microscopy is iso-
yl alcohol, which comes in two
es. commercial and anhydrous. The
is cheaper and should be used in
ng up dilutions with water. Reserve
nhydrous form for the final step.
the general routine, you will need a
of each of the following strengths:
0, 70, 82, 95, and 100 per cent. Re-
the commercial isopropyl as 95 per
the anhydrous as absolute alcohol.
do you go about making up a 35
ent solution from a 95 per cent
? Sounds like a math problem, but
ethod is very simple. Use a grad-
cylinder marked for 100 cc.; fill to
5 cc. mark with alcohol. then add
to bring the mixture up to the 95
ark. The rule is to use the 95 per
lcohol to the amount of dilution
ed, and then to add water to bring
he 95 cc. level. Fleas should be left
minutes in each successive solu-
f 50, 70, 95, and 100 per cent.



MAGNIFICATION can be obtained by
ding drop of water in metal loop.

xtra step is required in mounting
ntire insects—*positioning*. Nothing
worse or is more useless than a
in which the legs are entangled or
ings and antennae, when present,
askew. This can be avoided by in-
g the butt end of a fine needle into
ge round match stick (kitchen
) or dowel. which acts as a han-
nd securing it with tape. When the
is in the first alcohol, arrange the
naturally with the needle's point.
legs should be neither straight nor
against the body; pull them out so
ach one is bent at an obtuse angle
at each joint. none hiding the others; pull out the mouth parts so that they will be clearly visible. With other kinds of insects the antennae and wings will also require arranging. You will doubtless have to use bits of glass as wedges to keep all parts in place until the joints are completely hardened by the higher percentages of alcohol.

The preparation is now in a very delicate state, and care must be used to prevent spoiling the positioning. Remove each successive reagent by sucking it up into a pipette and add each new fluid by gently pipetting it on. Liquid can also be soaked up with paper toweling. Never let the specimen become dry at any time. After treatment in the last alcohol, use a half-and-half mixture of 100 per cent alcohol and xylene for fifteen minutes, then pure xylene for a like time. Swim the flea onto a slide, using copious amounts of xylene, or work a slide under the insect and swim it to the center. Tilt the slide to drain off excess fluid, or blot it up, then add the mountant, make a final inspection for positions of parts, and put on the cover glass.

Before the cover glass is applied, *cover glass props* are in order in most cases. The object is to raise the glass slightly so that it will not crush the specimen. For this purpose use bits of broken cover glass, one small piece in each corner, or snips of a thin sheet of cellulose acetate. One of our illustrations shows pieces of thin glass rod, drawn out under a flame, to prop the cover over a whole mount of a bug. This process aids in preventing breakage of the fragile glass itself.

In mounting insect parts. treat antennae. mouth parts, and legs, if thick or darkly colored. in the same manner. Gauzy wings do not require potashing, but thick. chitinous ones may. Before long we shall tell you something about the knowledge that may be gleaned from slides of this nature. It is really out of our world; it is an excursion into the world of the double tripod—the world of the six-legged insects—and the discovery of some of their fascinating modes of life.

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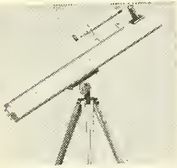

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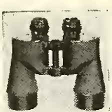

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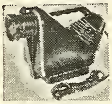

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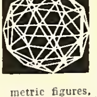

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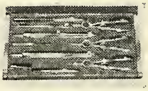

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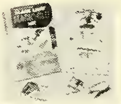

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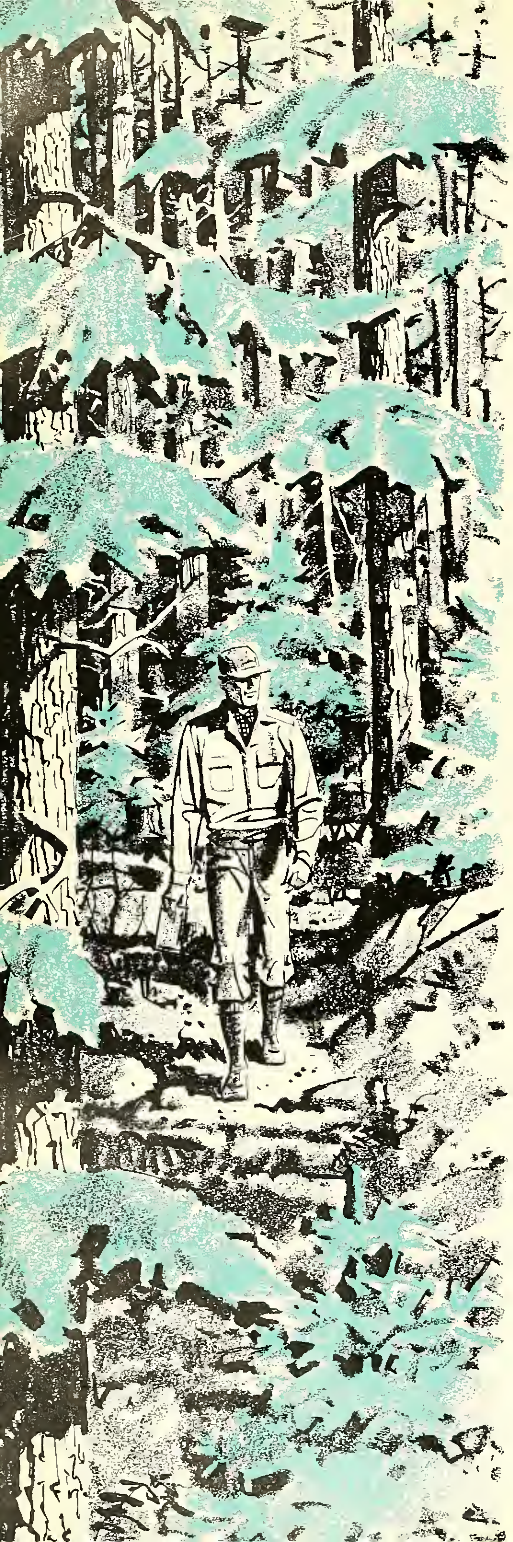

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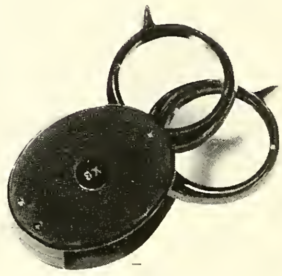

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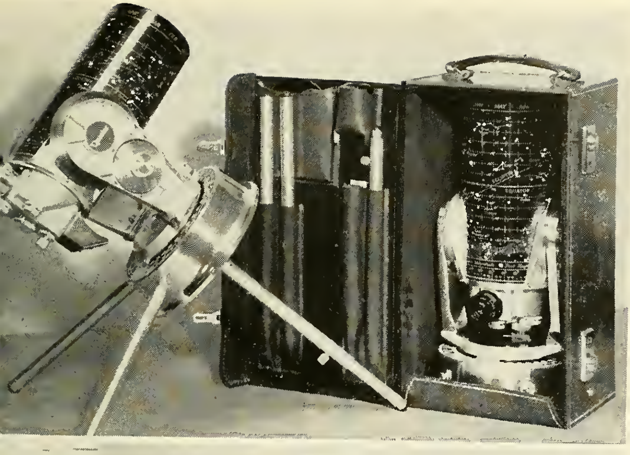

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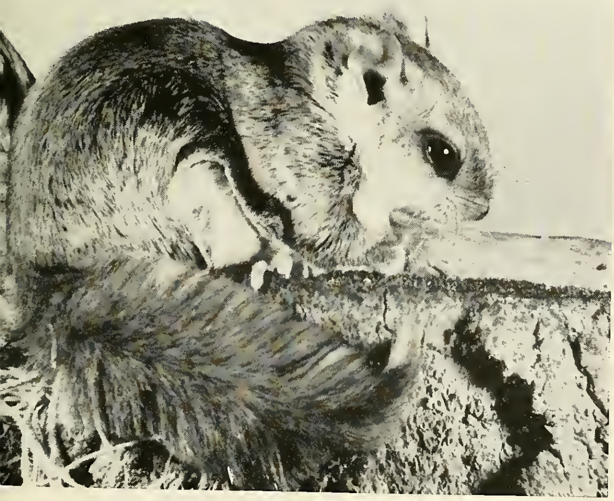

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DEPARTMENTS

BOOKS FOR THE BACKYARD ASTRONOMER — *James S. Pickering*
CELESTIAL EVENTS — *K. L. Franklin*
SKY REPORTER — *Simone Daro Gossner*
WASHINGTON NEWSLETTER — *Richard W. Westwood*

COVER: An intrepid explorer may start at the Mediterranean coast of Alg
and, after traveling due south some eight hundred miles into the Sahara De
find scenes similar to the one on the cover. Few people have ventured into t
wastes, but archeologist Henri Lhote and his companions were on the
of early cultures. In the Tassili massif, not far from the site of the c
picture, they found rock paintings establishing the fact that once oxen gra
elephants wallowed in water holes, and giraffes browsed contentedly in this
desiccated terrain. For their reconstruction of this prehistoric record, see page

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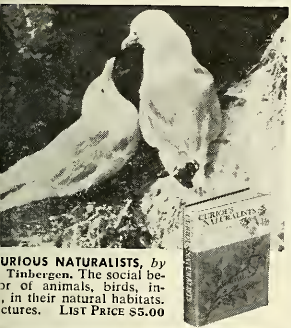

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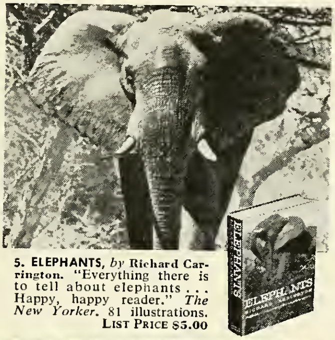

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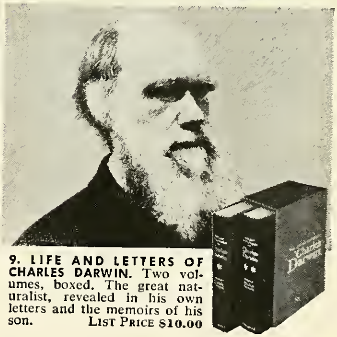

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Reviews

Books for the Backyard Astronomer

By James S. Pickering

THE WINTER IS LONG PAST, and even the rain is over and gone. The voice of the turtle is heard in our land. This is the time, between the passing of cold weather and the boom in the mosquito population, when the backyard astronomer can pursue his hobby with a minimum of discomfort. Here, to help him along, is a handful of new books dealing with this oldest of sciences. Taken in proper order, they may well lead those who are interested in the right direction. If pursued, they will encompass much of modern astronomy.

For the complete neophyte, one of the best jumping-off books that has come along in many years is *The Sky Observer's Guide*, by Margaret and Newton Mayall, and Jerome Wykoff. Paintings and diagrams by John Polgreen. Golden Press, New York, 1959; 125 pp., $2.95. This modest book, written by a team of four people—all of whom have been active in the American Association of Variable Star Observers—is exactly what it purports to be: a concise handbook of essential information for the amateur who has the urge to see for himself. Simply and with an economy of words, the non-professional observer is told how to use his equipment, what he should be able to see with it, where these phenomena may be found and why his instruments work. Lucidity is the order of the day, and readers of this little book should be spared the tooth-grinding frustration that is too often the lot of the beginner. Obviously, it is not possible to cover all of astronomy in 125 pages, but the basic information is here, together with tips for getting the most out of equipment and experience. Wherever possible, the authors have given useful leads to additional material.

A valuable by-product of this sort of condensation is a number of lists and tables: these add much to the value of the work for reference. The lists are not exhaustive—nor are they intended to be—but they contain the outstanding examples in the categories they cover.

It should be added that the drawings and diagrams are of high quality.
are, in addition, many fine photog
Most of these come from the sta
sources for such pictures—the fi
the great observatories—but son
markable "backyard" photographs
as you and I might have taken,
been included among the pictures

One or two mishaps have slippe
the authors, editor, and proofre
In one tabulation, the multiple
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life to the Great Nebula in Ori
listed as Sigma Orionis: in the ca
accompanying some photographs
moon, east and west directions a
versed. But such minor transgre
should not be allowed to put the re
off: *The Sky Observer's Guide*
intended as the last word in astro
but it is an excellent first word.

I am sure that the authors of *Th*
Observer's Guide hope their
will spur some beginning astron
on to further study. For these, *El*

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stronomy—by Otto Struve, Beverly
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d as the next step. And it is a
step, covering all the great dis-
between simple acquaintance and
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Perhaps the authors have re-
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te, they have admirably expressed
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d the all-pervading order that lies
them. This is a big picture, and
not easy to make it so plain.

rest of the book provides the foun-
ion upon which the first chapter
This starts with a summary of the
nental principles of physics—and
onomy, which depends so much
physical properties. These are the
als, the tools of the trade. The
rge part of the book applies these
o the study of that tiny, local
zation of which the earth is a part
olar system. Wisely, the authors
ot included the sun in this section,
he sun is a star and is more prop-
eated in a subsequent discussion,
it provides a transition from the
ystem to stellar and galactic as-
ny: the nature of the stars, their
s, their distribution in the galax-
d in smaller organizations. The
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e than a hundred celestial photo-
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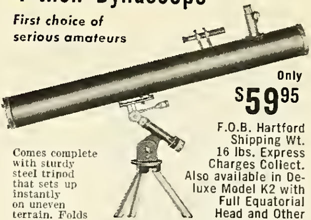

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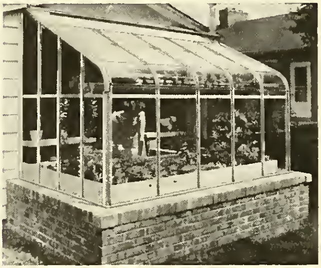

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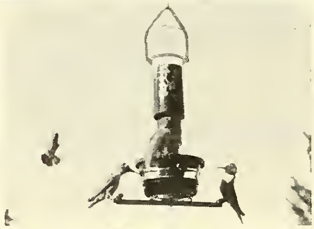

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less, all the major problems have dealt with and answered in the of our present knowledge. It is all l to know this book is to know all bu smaller, extraneous details concer the individual members of the univ The writing is spare and concise, no attempt has been made to imp spurious glamor to the subject. Be this is business, it is to be hoped the amateur will not shy away fro For this *is* astronomy.

A generation ago, the field of nomical books in the En language was dominated by one vo *Splendours of the Heavens.* Publi as the spelling indicates, in Eng this was a large, dictionary-sized ume, profusely illustrated and exhi proudly by the few astronomers could afford to own it.

This honored place has now taken by another magnificent boo *Larousse Encyclopedia of Astro* Photographs and diagrams. 506 $15.00. Prometheus Press, New 1959. The volume was writte Lucien Rudaux and Gerard de Va leurs, both astronomers of note. translated by Michael Guest and B. Sidgwick of the Royal Astrono Society, who have both written and well on their own accounts vision of the book, presumably to it up to date and bridge the gap o years between its original public and the present English edition. done by Z. Kopal, Professor of A omy at the University of Manches England. Finally, Fred L. Whi Professor of Astronomy at Harvar written a new introduction.

This is an impressive list of n and the contents of this volume sub tiate the prestige of the men inv Every facet of astronomy is pres here in a manner that is perfectl derstandable to an intelligent re nor need this reader have an edu in science. Every phase of the is treated in an eminently rea straightforward style.

On the minus side of the ledge should point out that several nomical concepts—valid in 1948 superseded by more recent advan knowledge—are, unfortunately, st the book. Again, far too little spa been given to radio astronomy for a of this scope. Then, too, the photog —which are superb—are from the F observatories, understandably en or from Mt. Wilson, but there is n that was taken by the 200-inch Reflector at Mt. Palomar. It is tru this great telescope was dedicat 1947 and that the original, Frenc tion could not, therefore, have cont a 200-inch photograph; but it is that space was not found for so them in this new edition.

lly, we note with churlish malevo- that even so magnificent a book is not free from the typographical that break the hearts of editors. of the many valuable tables, for ce, the distance of Sirius is given light years. But I am sure this accepted as one of those inevit- ings by every reader and not as ion in celestial measurements.

these few debits disposed of; it be said that this is a book to ven the coldest of professional omers delight. It is the book that ll exhibit to his less fortunate , holding it carefully and proudly, utioning them to keep their big, gers off the plates. This is a pre- on volume, a fitting prize to the t who has begun with *The Sky er's Guide* and gone on through *tary Astronomy*. It is a beautiful manufacturing and printing and a delight to own and to study. illustrations are like icing on this icent cake. The publishers say ere are 806 of them. I have not d them, but this appears to be a British understatement. There is a page that does not have one re smaller pictures in the text. are twelve color plates and many ge black and white illustrations. of the great problems that must have been encountered in the preparation of this edition was the change of the legends on many of the diagrams from French into English. Whether this meant that most of the diagrams had to be completely re-drawn or not, I do not know, but the fact that the job was done so well is evidence of the care and attention that the volume received.

It is not often that one who reviews astronomical books has any chance of treating the topical or newsworthy. The recent Russian achievement of photographing the hidden side of the moon, however, has made such topicality not only possible but desirable.

The Other Side of the Moon—translated by J. B. Sykes. Photographs and diagrams. 36 pp., $2.50, issued for the U.S.S.R. Academy of Sciences by Pergamon Press, 1960—is a completely unadorned account of this staggering feat.

The slim volume opens with a foreword by A. N. Nesmeyanov, President of the U.S.S.R. Academy of Sciences, in which the implications of satellite photography are discussed. The rest of the book is straight reporting. Perhaps to the detriment of the work, there are no detailed scientific data in it.

The diagrams that show the orbit the vehicle followed are unusually clear and understandable. The drawing of the satellite, however, would certainly not allow anyone to duplicate the device in a home workshop. The photographs of the moon (and there are only two photographs, both printed several times) are the same pictures that were first released—and appeared in almost every newspaper—a few months ago.

These pictures must be accepted as authentic. They are not good pictures, but the remarkable point is that there are any pictures at all. They were taken at the least favorable time, so far as the lighting of the moon was concerned. The face of the moon in the photographs is almost fully illuminated, thereby eliminating practically all of the shadows that would have given definition to the markings and accentuated details.

The intricate process of taking the pictures—aiming the vehicle, exposing the film, developing and drying it—took about forty minutes. The result was transmitted to receiving stations in Russia when the vehicle had later reached a favorable position. It may be that these pictures were the only ones obtained, but it would further have crowned the Russian achievement if more than two of them had been reproduced.

More than anything else, this little book is a souvenir of a momentous event—the official record of a vast step forward in man's eternal quest for knowledge.

IT'S A PUZZLEMENT

The reproductions shown here are from originals in the collections of the American Museum of Natural History.

1
BATEKE FIGURE—The original of this figure was carved in wood by the Bateke tribe of French Equatorial Africa. It is a fetish of a tribal elder wearing a characteristic crested headdress. Height 14¾ inches.
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2
VERA CRUZ BUST—Smiling heads of the type shown occur in a limited area in central Vera Cruz and date to about 1000 AD. The brown stone of the original is captured in this handsome reproduction. Height 10½ inches including base.
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3
LAMAIST BUDDHA—This Buddha is from the Museum's Tibetan collection and represents "The Buddha of Infinite Light". It has a gilt finish and is mounted on a black wood base. Height 6 inches.
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4
CHINESE ELEPHANT—The original carving is from the Drummond collection in this museum and is considered to be of the Kien-Lung period (1736-1796). Height 2 inches. A limited quantity is available.
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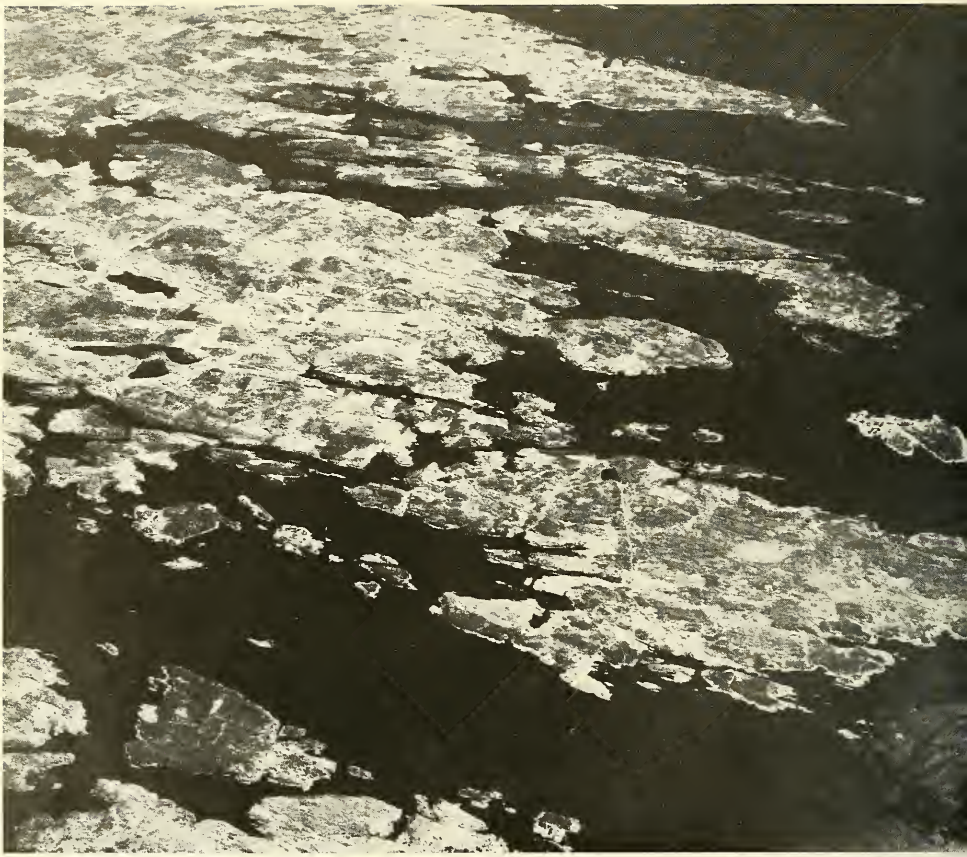


Boothbay Harbor area of Maine coast exhibits features of hard-rock shore line "drowned" by rise of sea level during geologically recent time. Resistant rocks have not y sufficient material for production of well-defined be

Edge of the Land

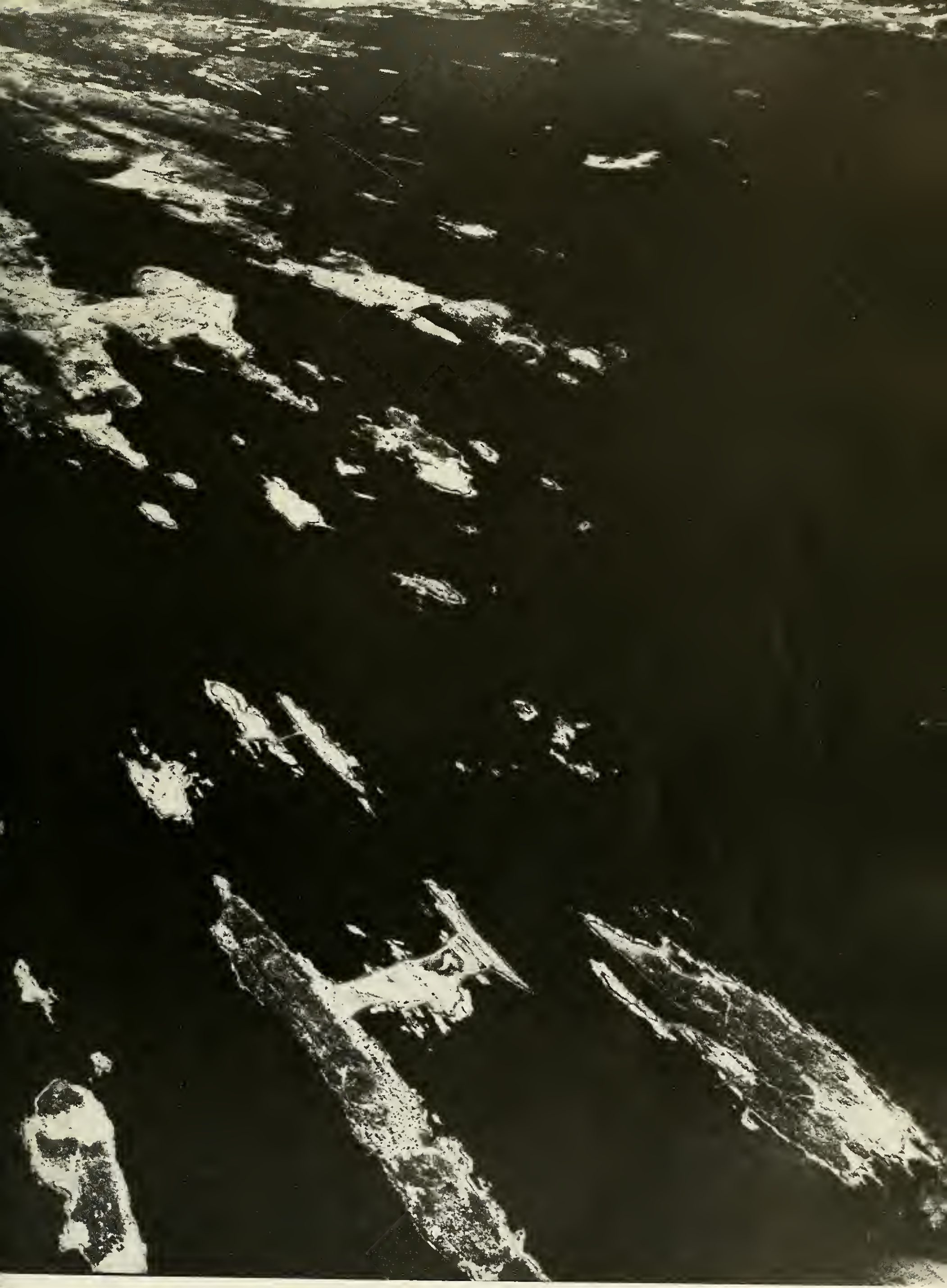
The sea's attack makes shore lines places of constant cha

By John A. Shimer

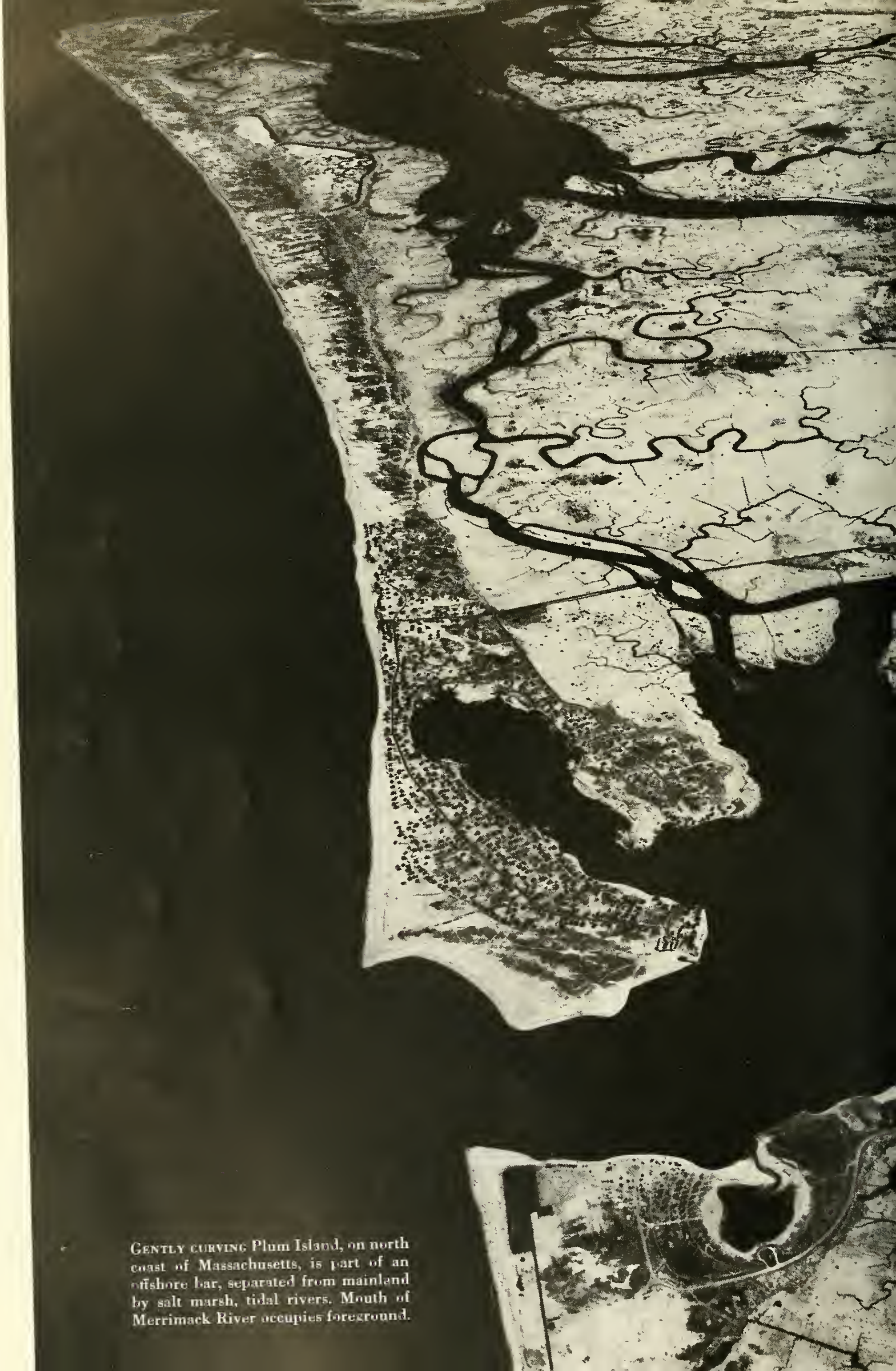
The edge of the land, where it meets the sea, holds a never-ending fascination for us. Here we are conscious of the timeless quality of waves and tides, of the eternal ebb and flow of the waters against the land. Because of the restless motion and turmoil of the ocean, coastal scenery is one of the least secure, the most evanescent of any on the face of the earth. We are aware here, as nowhere else, of the unceasing activity of the forces that have molded the earth's crust in the past and are shaping it today.

Sometimes, after a storm, slight changes in a familiar pattern are discernible along the seacoast—perhaps a subtle difference in the curve of an inlet, or in the outline of a dune against the sky. Perhaps there is a new line of pebbles where there was none before. There are times when storms alter scenery more dramatically– waves break through barriers a croach on the land, making new new islands, a new shore line.

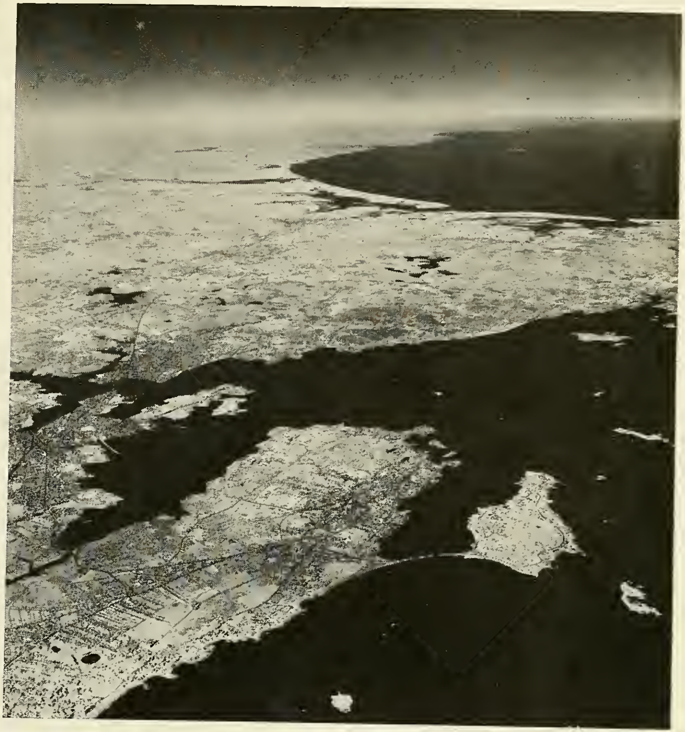
Yet, the day-to-day, or sto storm, shifting of easily move and pebbles along a shore plays atively minor part in the lon action of the sea. Less sudde more impressive is the action of on the solid parts of the land,



R ARRANGEMENT of islands on Maine coast, well shown w of Casco Bay, *above*, resulted from the drowning of parallel ridges and valleys by rise in sea level. Islands represent ridge tops; estuaries occupy the former lowlands.



GENTLY CURVING Plum Island, on north coast of Massachusetts, is part of an offshore bar, separated from mainland by salt marsh, tidal rivers. Mouth of Merrimack River occupies foreground.



Aerial view, *above,* was taken from a point near Marblehead, looking to the north. In middle distance is Cape Ann, jutting to the east. Beyond is Castle Neck and Plum Island; in far distance, New Hampshire and Maine coast lines.

yield slowly to the ceaseless pounding of waves and the battering of storm-tossed sand and gravel. The steep coastal cliffs we see today look out over the moving waters that have been gnawing away at them for hundreds, perhaps thousands, of years.

LANDSCAPES are also created by oceans in another and totally different way. A change in sea level produces a unique type of coastal scenery, quite unlike that carved by waves. When the level of the sea rises, it floods low coastal lands, isolating hills to create islands and drowning river valleys to form bays.

The shores of New England afford excellent examples of landscapes that have come into being along a drowned coast, as well as those coastal forms that result from the more direct work of the sea. The scenery along the coast of Maine, in Boston Harbor, and on the outer side of Cape Cod, shows the characteristic results of the sea's activities on contrasting types of land. The ocean drowned the entire coast of New England at approximately the same time. While the rocks along the Maine shore are hard and not easily worn away, the softer materials farther south have yielded readily to the combined action of the Atlantic Ocean's encroaching waves and currents.

For the traveler, a trip following the edge of the land along the coast of Maine is tortuous. Deep estuaries, extending miles inland to form fine harbors, alternate with bold headlands that jut well out to sea—promontories from which many islands are strung, filling in the nearer scene before the open sea is reached. Here, land and sea interpenetrate to a truly remarkable degree. For example, the distance from Portland, Maine, to the Canadian

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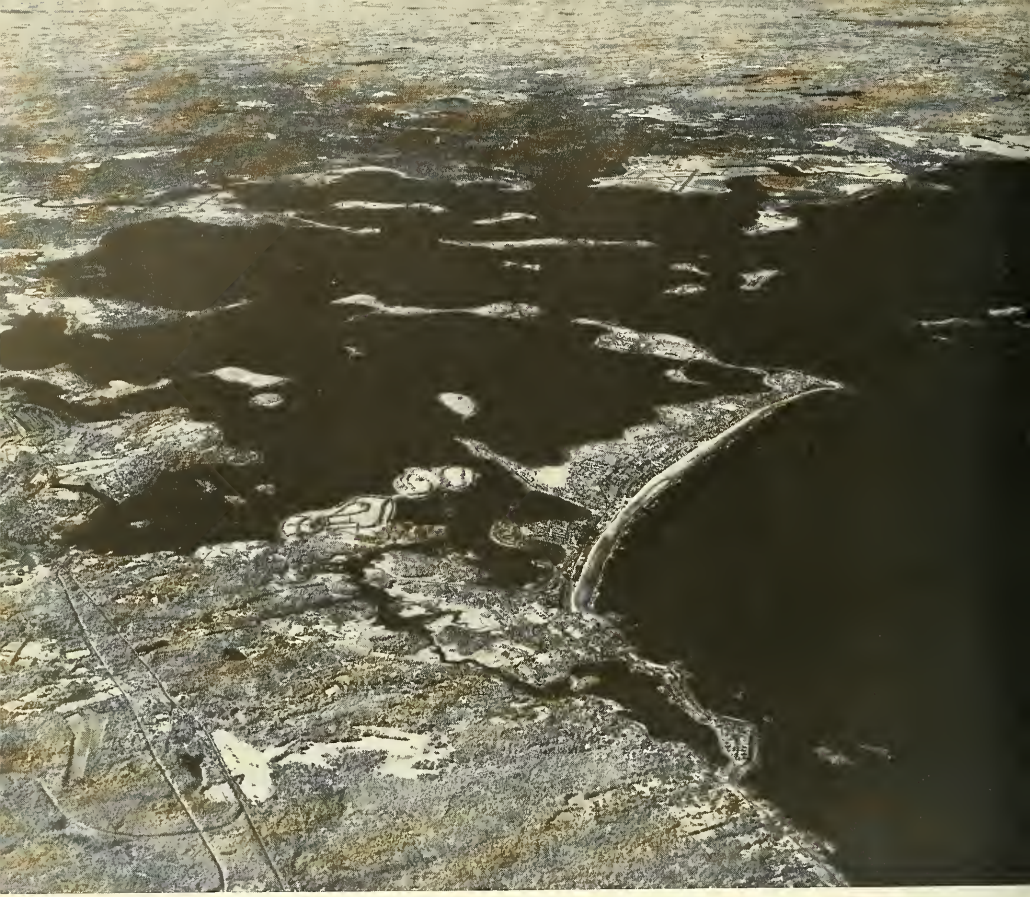
Dr. Shimer, who is a geologist at Brooklyn College, is the author of the current book *This Sculptured Earth* (Columbia), from which the article on these pages is excerpted.



Boston Harbor, formed by the drowning of river valleys, owes rich variety of shore features to attack of waves on loose glacial debris. Prominent in foreground, *abov*
Nantasket Beach tombolo, tying island group to mainl

border is about 200 miles by air: via the shore line, it is over 2,000 miles—about the distance from Maine to the Rocky Mountains.

From the tops of many of the higher hills in Acadia National Park, on Mount Desert Island, an ideal view of this irregular shore line can be obtained. An island-studded seascape is spread out at one's feet. These islands are not haphazardly arranged, but appear to be roughly organized into long files, as though they were marching out to sea one after another. A number of these island groups are in sight, all trending roughly north to south. They seem to be partially submerged continuations of promontories that we can see on the mainland to the north. To the south, toward the horizon, the lines of islands gradually disappear, the underwater ridges getting lower, until we can only guess that they continue beneath the ocean's surface.

Storms along this granite coast bring breakers, which concentrate on the rocky headlands and outer sides of the islands. Hurling sand and gravel against the land, they have produced such features as Anemone Cave and the neighboring cliffs on the seaward side of Mount Desert. Broken material from the headlands has formed small beaches of sand and gravel between the promontories or sand bars part way across some estuaries.

At the same time that the headlands are being worn away, the streams that enter the landward end of the estuaries, miles from the open sea, are bringing sand, mud, and gravel, which they dump when their flow is checked on entering the ocean. In some pl
small, growing deltas can be fo
These deltas will not be disturbe
the large waves that break on the h
lands or by the currents that pr
there. Thus, the zigzag, deeply in
ed coast line of Maine would see
be heading for inevitable destruc
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While waves and currents are cu
off and filling in the seaward en
the bays, their landward ends ar
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Manifestly, this coast line of
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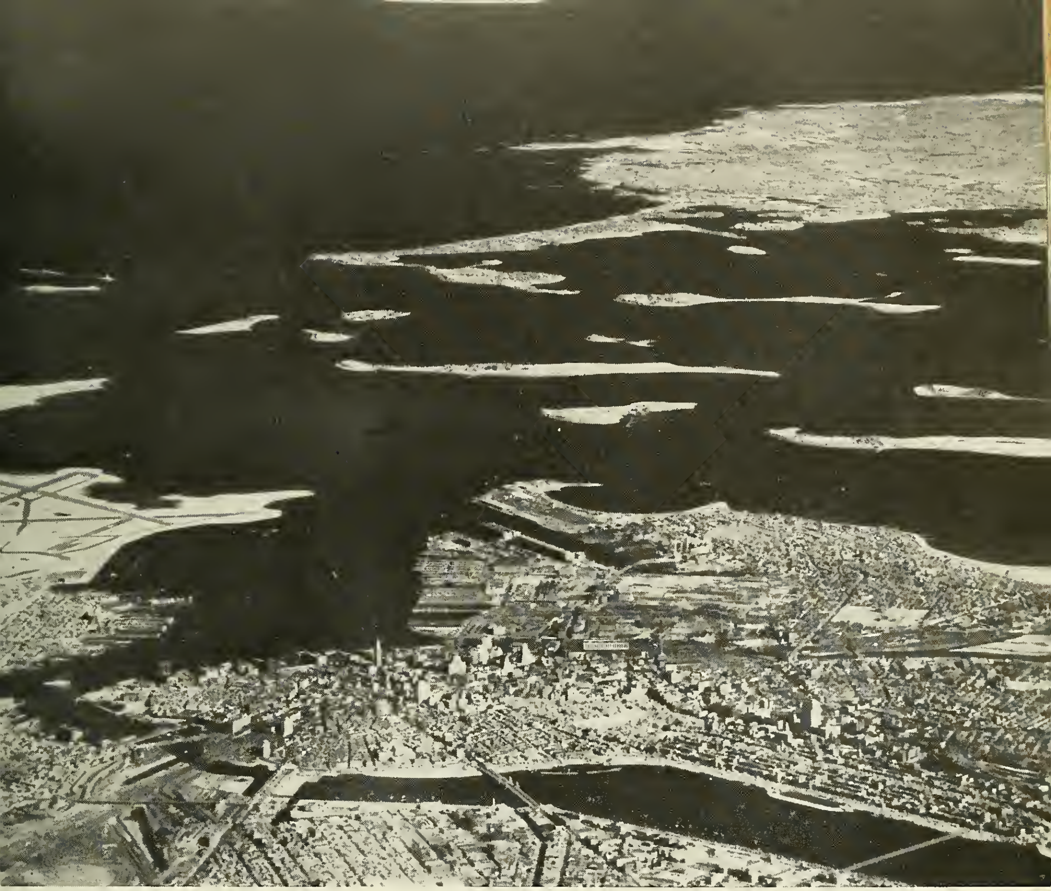
the hills into islands. This



s of glacially formed drumlins dot surface of Boston
bor as roughly parallel islands. Beyond drumlin group is Nantasket Beach and Hull shore; clearly visible in far background is Cape Cod Peninsula, some fifty miles away.

owned coast line." It is not sur-
ing that dredgers in the coastal
bors occasionally bring up decom-
ed grass roots and peat.

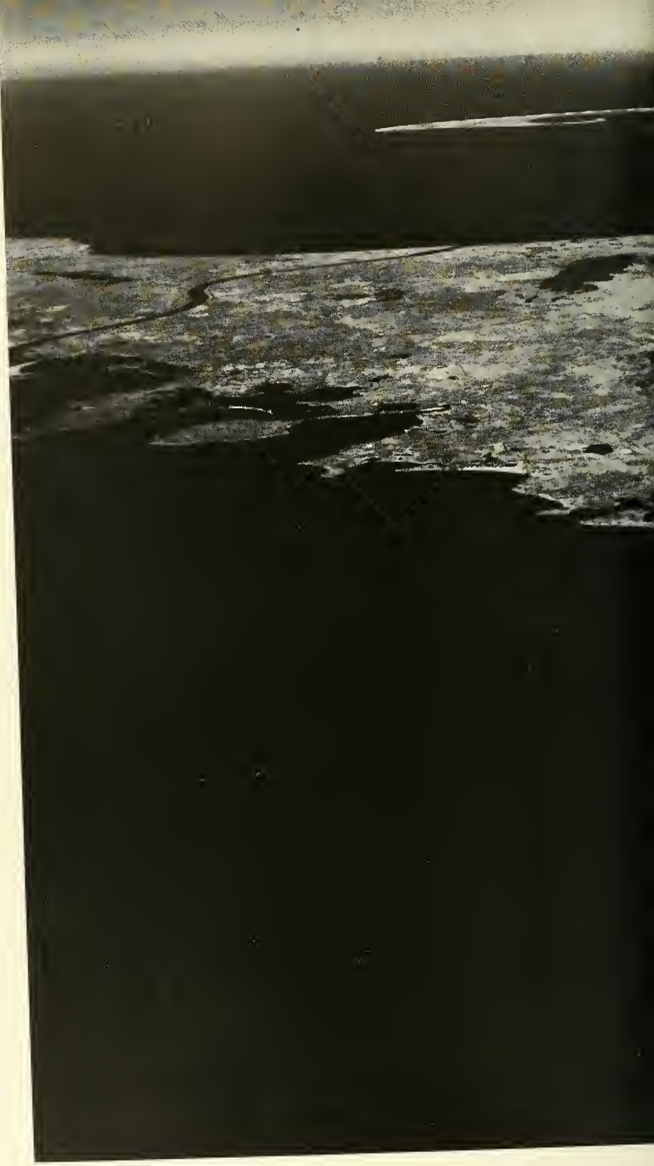
he remarkable alignment of estu-
s and islands is a product of the
ngement of the valleys and ridges,
ch existed prior to drowning. The
erwater alignment of ledges is the
e as that of the islands. Looking
nd, beyond the reach of the sea,
same ridge and valley pattern is
to continue.

he eventual fate of the coast of
ne appears inescapable. An essen-
y straight shore, with purely sea-
duced scenery, is inevitable, *if* the
l of the sea does not rise or fall,
thus start the cycle of wave ero-
all over again. Wave-cut cliffs,
nting the sea, will alternate with
d and gravel beaches, curving
slightly back into the land where estuaries were formerly found. But the sea's action on such a rocky coast is slow, and succeeding generations will notice very little change in the contour of the shore.

When the sea attacks material less resistant than the rocks of Maine, it can produce very noticeable changes in a relatively short time. A comparison of the Maine coast with Boston Harbor nicely demonstrates this difference. Both areas were drowned at about the same time, beginning about ten thousand years ago. Yet the Boston area contains a far greater abundance of fine beaches and wave-cut cliffs than are to be found along the coast of Maine, and the impact of the sea on the Massachusetts shore is evident nearly everywhere.

At Boston, the sea inundated a land liberally covered with piles of loose debris, a great deal of which had been shaped into low, rounded hills before the drowning. These deposits—of gravel, sand, and mud, all mixed together—are called drumlins. They were left by the large continental ice sheet that disappeared from New England scarcely ten thousand years ago. Most of the drumlins have an elliptical ground plan, and are so oriented that their long axes run roughly northwest to southeast, reflecting the direction of motion of the glacier as it overrode them and smoothed them into their present streamlined shape. These piles vary somewhat in size, commonly being from fifty to a hundred and fifty feet high, and from a few hundred yards to nearly a mile in length. After the ice sheet withdrew, the sea rose

Cape Cod at right, consists of glacial moraine and its outwash plain, exposed to destructive attack of the open sea.



and flooded the lowland areas, with the result that the tops of many drumlins now protrude from the water to form the typically elliptical islands that dot Boston Harbor.

An excellent view over the Harbor can be obtained from the summit of Weymouth Great Hill. From the top of this drumlin, a bewildering display of islands, estuaries, promontories, beaches, and straits unfolds to the north. In the foreground, toward the east, is Grape Island—with a small cliff notched on its seaward edge. Close by is Bumkin Island, its beautiful, smooth shape looming out of the water, looking like some gargantuan sea turtle basking in the sun. Peddocks Island, a little farther off toward the north, is composed of a number of drumlins joined together by sand beaches; the cliffed edges of two of the drumlins show the source of much of the material that makes up the connecting beaches. Farther to the east, the rounded tops of several drumlins show up against the horizon; they now form the high, rounded parts of Nantasket Beach and Hull.

This peninsula has, very roughly, the shape of the numeral "seven," with its base attached to the mainland. It extends northward some four miles and then westward a mile and a half more. Its principal feature is a fine sand beach that connects the drumlin hills to the mainland. Such a sand bar, connecting a former island to the mainland, is called a tombolo. In general, the production of any tombolo implies, first, the formation of an island, and then the joining of the island to the mainland by a sand or gravel beach, built by waves and currents. On the north side of Boston Harbor, a counterpart to Nantasket Beach exists in Lynn Beach, which has tied the rocky islands of Big and Little Nahant to the mainland.

The sea still has a job to do in the Boston Harbor area before the results of its activity dominate the landscape and evidence of the past drowning is altogether destroyed. But the work is in progress. Just as in Maine, the estuaries, like the drowned seaward ends of the Neponset and Mystic rivers, are silting up. Far more than in Maine, however, the coastal scenery here emphasizes the work of the sea. Beaches, sand bars, and the wave-cut seaward margins of the drumlins dominate the landscape of the harbor.

Cape Cod, south of Boston, is a peninsula surrounded and largely dominated by the sea. Jutting out miles from the mainland into the Atlantic, this land is completely exposed to the ocean's relentless activities. Made up originally of glacial debris, the Cape is easily eroded: nowhere ca smallest ledge of bedrock be Wherever one may visit, there dence of the ocean's work.

The partially destroyed hea and the precipitous cliffs that fr open sea reveal the destructive of waves, while bars, beache sandspits tell of the ocean's op constructive role.

On the Atlantic side of the where the easternmost bulge

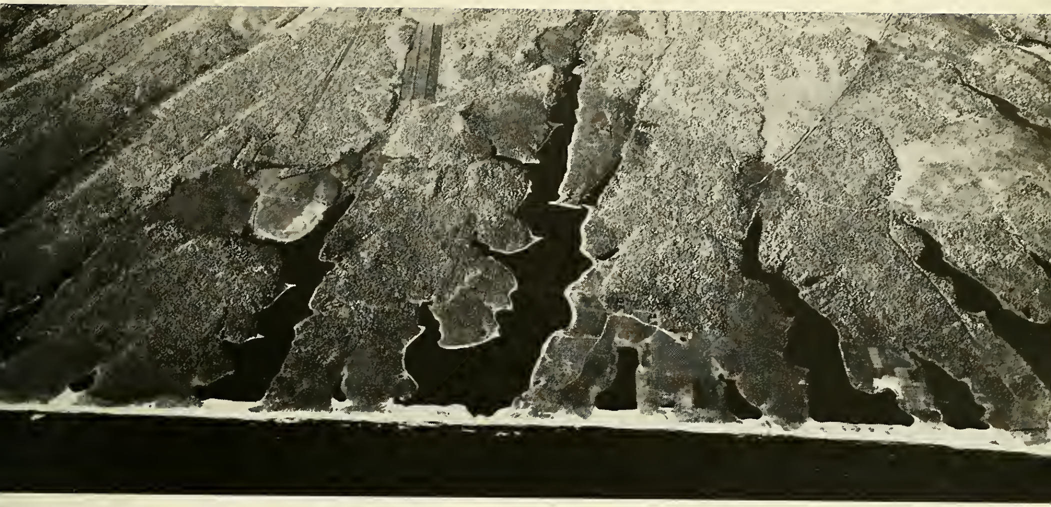
open water, the sea has been able its job of destruction without uption. Indeed, a visitor at Nau- each on a gray day of rain and may greatly fear for the perma- of the land on which he stands vonder how it has been able to the ravages of the sea for as long as. In winter during a northeast when flying spray whips across each in horizontal streaks, the shakes as the breakers crash on the shore. The roar of grinding sand and pebbles, as the waves break and return, forms a deep background to the high, shrill whistle of the wind.

The time to fear for the land is when such gale winds and waves are accompanied by a high tide. Then it is that the cliffs facing the ocean are undercut, landslides occur, and the land is visibly lessened.

The coast at Nauset Beach Lighthouse consists largely of ocean-produced features, both erosional and depositional. A line of cliffs faces the sea, where the wave action has been most intense. The material eroded from the cliffs has gone into the making of the beaches, which extend for miles. The beaches, in turn, are in the process of being washed away: northward, to form the hook of sand and gravel at Provincetown, and southward to form the Nauset Beaches and

Aerial camera catches pattern of underwater sands that constitute part of Nantucket Shoals, south of Cape Cod.

Shoals cover large area east and southeast of Nan Island, and are site of first lightship in United



UARIES along the south shore of Martha's Vineyard, *ve,* have been cut off from open sea by baymouth bars. **Material forming bars has been supplied by truncation of promontories, and spread by waves and longshore currents.**

nomoy Point. The dividing line,
arating northward from southward
ting sand, is somewhere just north
Nauset Beach Lighthouse, roughly
re the curve of the Cape projects
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outh of this point, the drowned
ure of the Cape coast is still ob-
s in the inlets at Eastham and the
e expanse of Pleasant Bay. Both
hese estuaries have now been al-
t cut off from the sea by the growth
sand beaches. The southward
wth of these beaches in the form of
spits is obvious on maps, which
v the beaches with their northern
emities attached to the mainland,
e their southern ends terminate as
ted fingers in the water.

OST of the transportation of sand
and gravel along the Cape shore
complished at times of large waves
strong winds. Whenever waves hit
shore obliquely, a slow drift of
r in the general direction of the
motion is set up, and this drift
es the finer beach material in sus-
ion. The larger particles on the
h are also subject to a slow and
motion along the coast when-
waves hit at an angle. Each break-
vave carries individual sand and
el particles up the beach—as well
ightly along it—and then pulls
straight back down the slope
the undertow. In this way, as each
ese peripatetic particles is moved
up and then down the beach slope, it is also moved a short but still measurable amount in a direction parallel to that of the coast. Progress measured in terms of thousands of feet per day has been reported for material moved along the shore in this fashion.

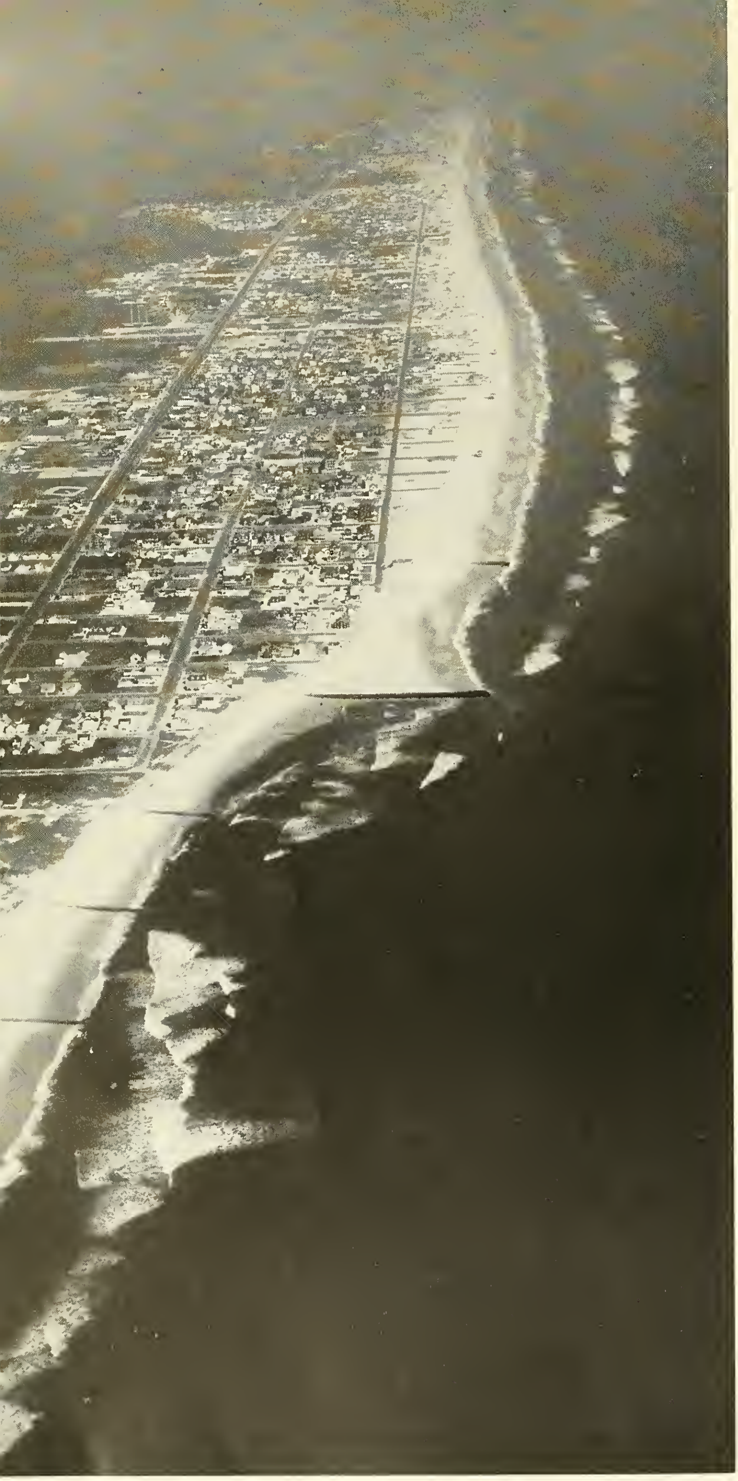
The coast extending northward from Nauset Beach Lighthouse to the tip of the Cape is entirely sea-formed and sea-controlled. A continuous beach, which hugs the shore, ends at the westernmost extremity of Cape Cod—Race Point Lighthouse, near Provincetown. For its last eight miles, this is a large sandspit, attached at one end to the mainland and built northwestward by the action of waves and currents. More recently, currents in Cape Cod Bay have moved some of this material again and used it in building Long Point, a hook-shaped deposit of sand that points eastward, in exactly the opposite direction from the principal hook, and partially encloses Provincetown Harbor. Thus we see that there has been a two-stage development of the present land form: the initial production of the major spit and then the formation of the parasitic Long Point.

From the top of the Pilgrim Monument, in Provincetown, on a clear day, the whole curve of the inside of Cape Cod can be traced southward and then westward, as far as the higher parts of the mainland near Plymouth, over twenty miles away.

To the north, from this point, a very fine collection of sand dunes is visible. Blown by the winds, the sands are often piled many feet above the reach of storm waves. They cover an area a mile or so wide on this seaward part of the Cape and extend for miles along the shore. The very irregular pattern of a typical dune field is obvious. Some small trees stand in the hollows, and grass sketchily covers the dunes themselves. Such a vegetation cover may help to anchor the dunes in position for a time, but the effect is only temporary, as a constant supply of new sand quickly buries and kills the grass and the trees.

Dunes, with their changing shapes and constant drifting, are among the most mobile of all landscape features. For their formation, the winds that shape them need only loose sand. In desert areas, the winds are continually at work rearranging the sands that are not held down by vegetation. Along ocean and lake shores, dunes are found wherever waves and currents keep washing up fresh and plentiful supplies of sand.

Moving south along the Atlantic coast, it is found that the geological pattern made by Pleasant Bay, and its ocean barrier of Nauset Beach, is repeated in many other places. The shores of Rhode Island, Connecticut, and Long Island are all characterized by the presence of estuaries, spits, and sand bars. The depositional features



are most extensive wherever so cial material is present, and l where the waves and currents their attack on bedrock.

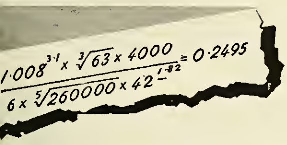
South of New York, the co New Jersey is almost one conti sand beach, backed in some st by low, wave-cut cliffs, and else by marshland, extensive lagoon drowned river valleys.

THE northern New Jersey sl composed of weak layers o sand, and gravel. As the sea wea shore away, small cliffs—only feet high—are produced. To the coast here from further de tions of the sea, concrete wall been built and stretches of the have been faced with large bl stone. Breakwaters, or groins also been built straight out fr shore to curb the drift of sand the beach. Despite this effort, few years there is a storm po enough to toss the stone blocks and to undermine the concrete With each such storm, a few inches or a few more feet of la surrendered to the sea.

There are still obvious est along the New Jersey coast, al enough time has elapsed sin area was drowned for a number smaller ones to have been oblit Offshore bars are especially not near the central part of the state the waves have scoured up the s sea floor to build barrier bea mile or more from the mainla goons of quiet water have been between these wave-built, offsho and the mainland.

In time, these barrier beach be pushed shoreward, as storm on the one hand toss sand and into the lagoon behind, and deposits, on the other, fill in th aries and lagoons from the lan The ultimate fate of this coast fore, will be the eventual oblit of the lagoons and estuaries, le low, intermittent wave-cut cliff, by a sand beach, extending fr end of the state to the other. a further rise or fall in the leve sea, the prevailing scenery then wholly a product of the sea's erosional warfare against th

BARRIER BEACHES of New Jerse as that of Beach Haven, *left*, their sand from scouring of se



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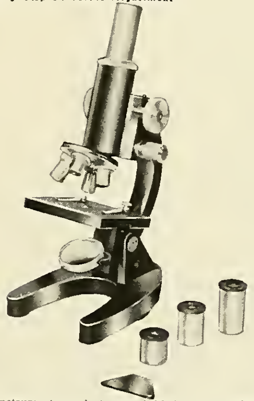

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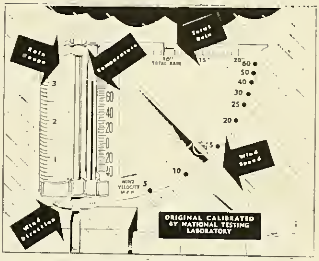

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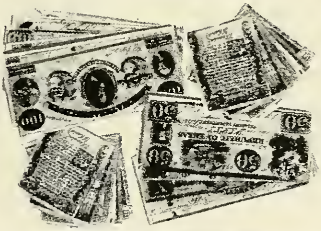

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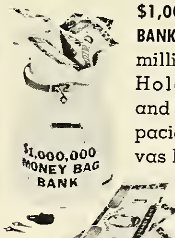

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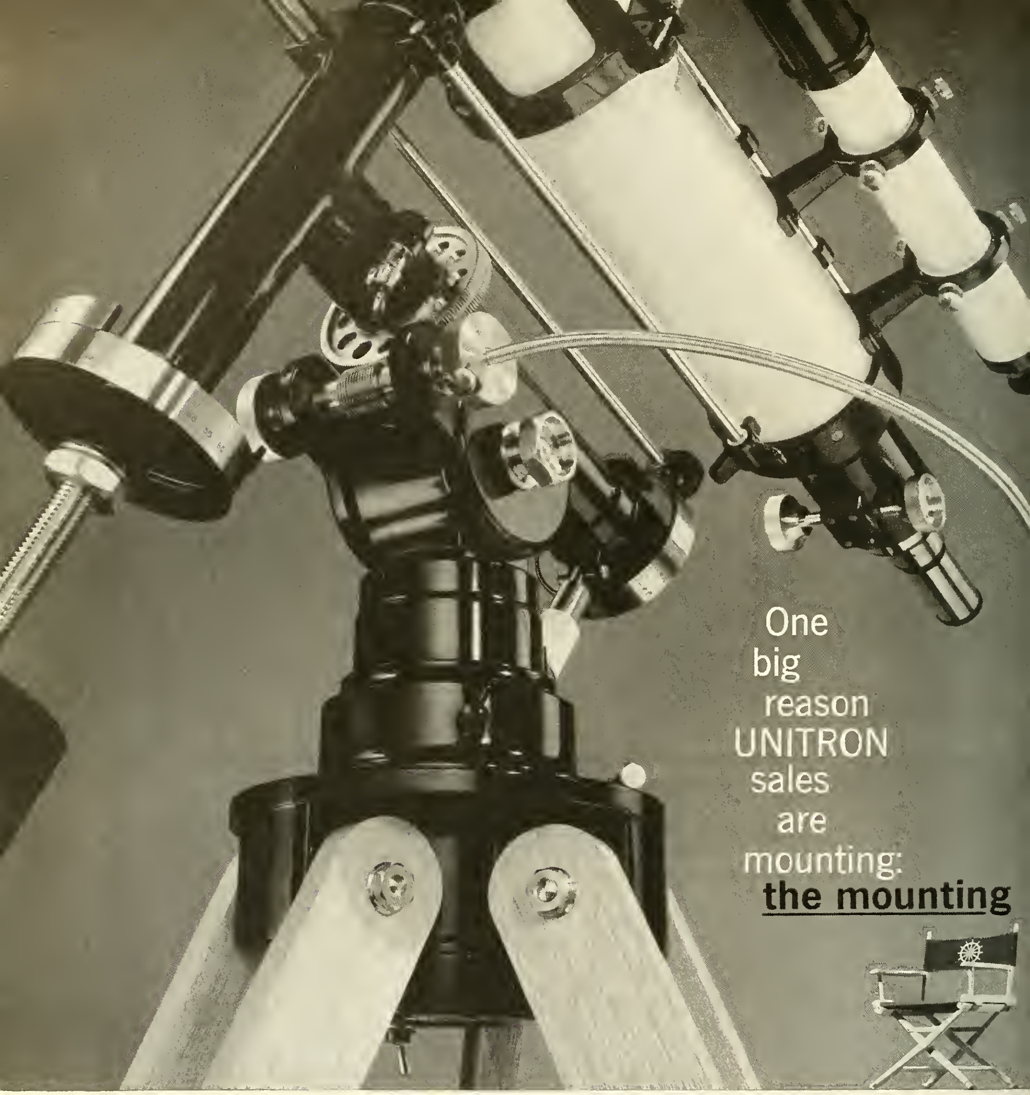

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The Water Walker

By C. H. Conaway

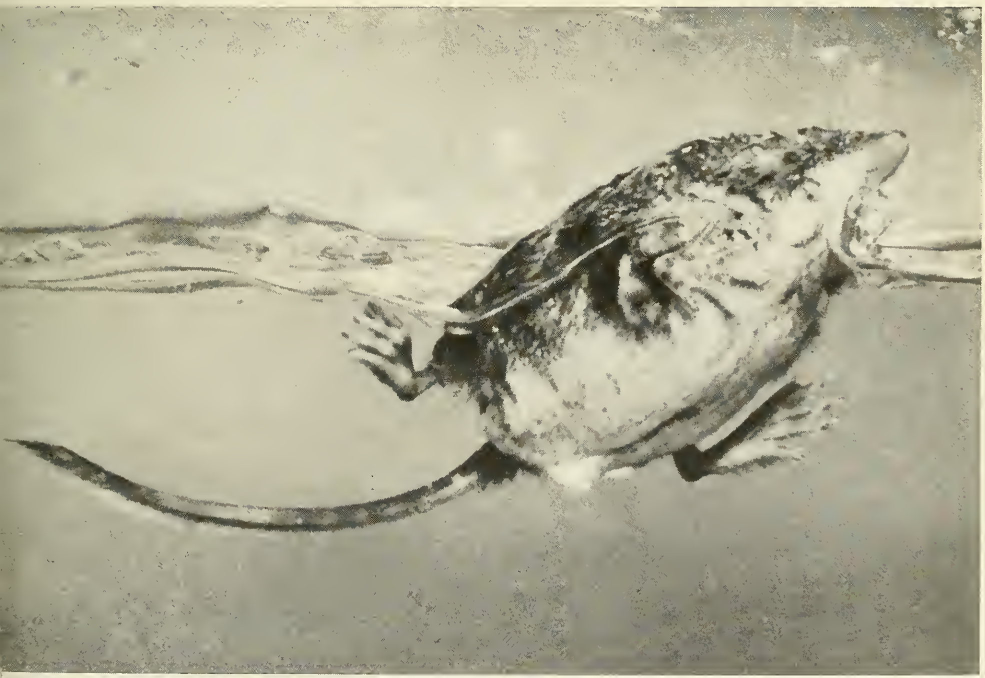
Photographs by Liselotte Dorfmüller

Looking something like a mouse and something like a mole, water shrew has dense fur, a pointed nose, and small eyes.

ONG THE MOST INTERESTING of all small insectivores are the several species of North American and Eura- water shrews. The animal pictured on these pages, the pean water shrew, *Neomys fodiens*, is remarkably ar in appearance and habits to our own North Amer- species, *Sorex palustris*. In the coniferous forests of h America, water shrews live along small streams. r range extends southward through the Appalachians e Smoky Mountains in the East and through the Rock- New Mexico in the West. Although common in their at, they are rarely seen, as they usually stay hidden r cover of overhanging banks and loose rocks to be d at the edge of the stream.

The water shrew has the general appearance of a small, sharp-nosed mouse. It is about six inches long over-all, with its tail composing almost half that length. The eyes are tiny and inconspicuous, as are the external ears. The fur is dense and uniformly a dark, slate color on the back and sides, and silvery gray on the underside.

The water shrew's major food items are various insects, which are taken both on the bank and in shallow water at the stream's edge. Aquatic insect larvae (chiefly May fly, caddis fly, and stone fly larvae) are the staple food items most frequently found in their stomachs. As with other shrews, their food requirements are enormous, and they eat slightly more than their own body weight in food each



FUR of the water shrew traps the air, gives the animal arkable buoyancy. This, coupled with its hair-fringed feet, which are disproportionately large, sometimes makes it appear that the shrew is running on top of the water.

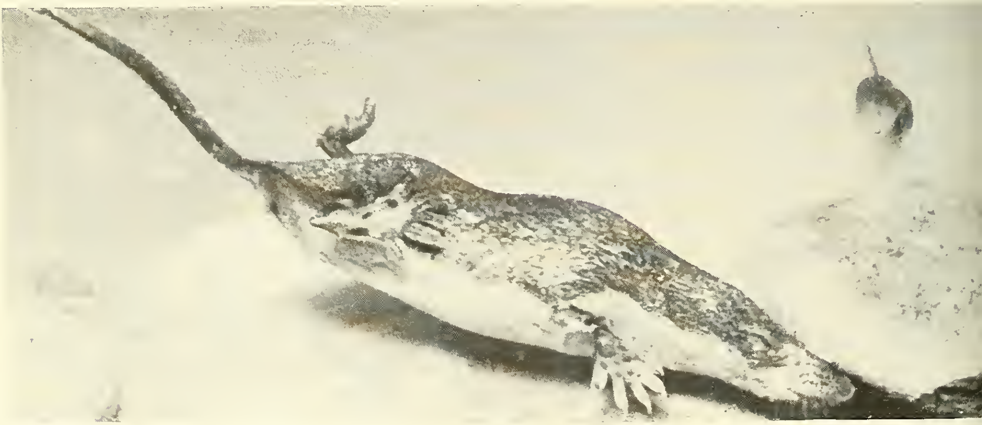
In the wild, the shrew usually prefers to feed on insect larvae, which it can find in the cover along streams' edges.

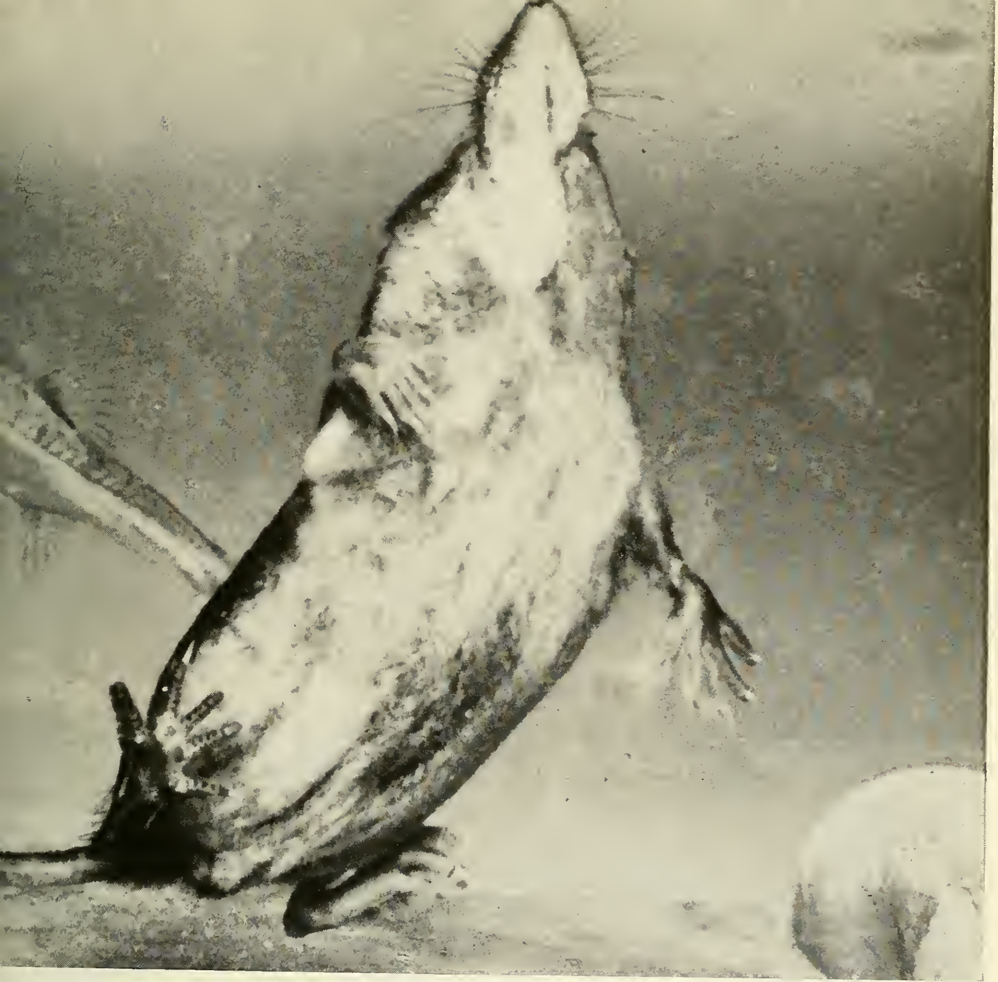
day. A captive animal, weighing 10 grams, ate an average of 10.3 grams of meat and fish every twenty-four hours.

Although these shrews are adept at both swimming and diving, they only occasionally enter deep water. Then it is usually only to "run" across the surface of a small pool and quickly disappear among the rocks at the far edge. Those persons fortunate enough to see this are often startled, since the water shrew does literally appear to run on the surface of water. Its large, fringed feet, and the buoyancy provided by air trapped in its dense fur, prevent it from sinking appreciably into the water. Perhaps one reason a shrew seldom ventures into open water is that it is highly vulnerable: water shrews have been found in the stomachs of trout and a number of other predaceous fish.

Although these little mammals are quite capable of catching small fish, they rarely do so in the wild. In American species that have been analyzed for food content, remains of fish were found in only one of eighty-seven stomachs. Probably only an occasional minnow or small fish, trapped in a pool, would normally be taken. In captivity, however, water shrews are able to catch fish in the confined space of an aquarium with considerable efficiency.

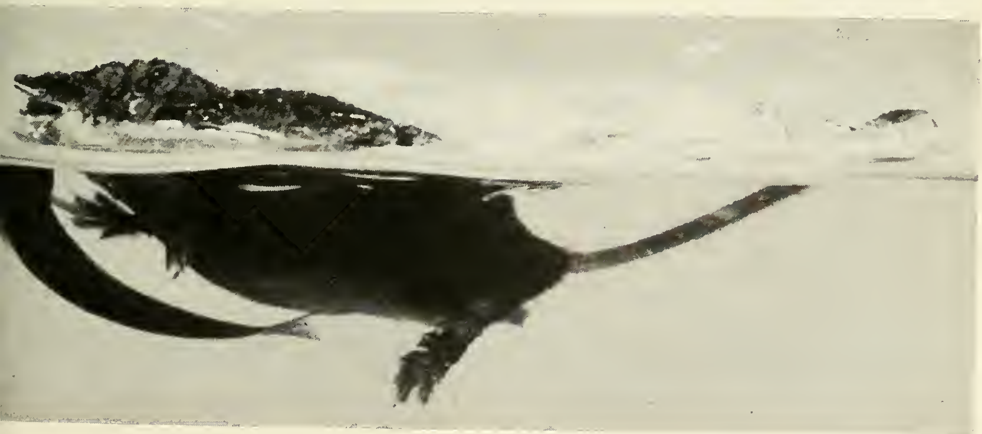
Swimming underwater, *below*, the shrew utilizes its tail as a rudder, and its bristly feet as efficient pad





APTIVITY, shrew avidly pursues minnow placed in an rium, *above*. Sheen on fur is from trapped air bubbles.

Shrew surfaces quickly after it has managed to secure its victim, *below*, which it invariably catches by the head.



Dr. Conaway is an associate professor of zoology at the University of Missouri. Mrs. Dorfmüller is a well-known nature photographer who makes her home in Munich, Germany.

When a water shrew first enters the water and dives beneath the surface, it has a noticeable silvery appearance, caused by air entrapped in the hair. The entire animal almost seems to be enclosed within a bubble. After a minute or so of active swimming, however, the air is lost, and the hair begins to wet. This is a serious hazard for the shrew, since heat loss—through the cold wet fur in contact with the skin—will cause the animal's death within a very few minutes. Thus its diving and swimming periods are of brief duration. When the shrew emerges from the water, it immediately begins to dry its fur by vigorously and rapidly grooming itself with its hind feet. The bristles fringing the hind feet act as a comb in this process. Within half a minute, it is almost entirely dry. While drying its fur, the shrew also eats whatever prey it has captured in the water. This renews the energy reserves for its rapidly metabolizing body, and aids in restoring the heat the animal has lost through exposure to the cold water.

In captivity, water shrews seem to learn to hunt fish with unusual avidity. One such captive animal was observed systematically searching its aquarium until all fish there were captured. Minnows that could not be eaten immediately were killed by a bite behind the head, and stacked on a rock like cordwood, heads all laid in the same direction.

Water shrews are intermittently active both day and night. After a period of hunting and feeding that may last as much as fifteen or twenty minutes, they sleep briefly. An animal that is moving about actively may suddenly fall on its side and sleep. On one occasion, a shrew running along a log at the water's edge was seen to go to sleep in this abrupt manner, and topple into the water.

More than any other animal, small shrews such as the water shrew seem constantly to walk a precarious tightrope between life and death. A period of several hours without food is sufficient to cause death from starvation. A few minutes' chilling with wet fur, and the animal dies from exposure. Failure to understand this characteristic underlies several common fallacies about shrews. One such belief is that they will die of "shock" if handled. Animals that have spent several hours confined in a trap or container may, indeed, die very suddenly if excited. Their last burst of activity simply exhausts their metabolic reserves, and they literally die from starvation. Well-fed animals, however, can be handled and actually treated rather roughly without any danger to their lives.

This failure to understand the shrew's continuous food requirement is responsible, too, for exaggerated ideas of their viciousness and savagery. These beliefs have arisen from accounts of the fierce fighting and cannibalism that occur when several shrews are confined together. With shrews, only a few hours are needed to reduce them to a shrew-eat-shrew level of starvation. For that matter, if mice are confined together without food and water for several days, the same thing will happen. From five to ten shrews of several species have been confined together successfully for several months in the bottom of a wash tub, with only sawdust on the bottom and a single, small community shelter. So long as adequate food and water were provided, it was discovered, neither conflict nor cannibalism arose.

Prolonged submersion may cause death, so shrew makes kill as quickly as possible and emerges from water to

While eating, shrew grooms fur with hind foot. In a short time, the dense, slate-colored coat has nearly dr

Body heat lost in water is restored by metabolism kept in balance through eating more than own weight every day.

Slightly damp, but with energy reserves now restored. shrew will soon either hunt again or quickly fall asleep.

CELESTIAL EVENTS

A list of astronomical occurrences for the second half of 19

JULY

July 2: The earth is at aphelion in its orbit, 94.5 million miles from the sun—the farthest it can be.

July 7: Saturn is in the opposite direction from the sun in our sky; it can be seen low in the southern sky at midnight, 840 million miles away, looking like a bright yellow star nearly of magnitude zero.

July 8: Tonight the moon, passing north of the planet Saturn, will be full, and also will be at its perigee, only 221,900 miles from the earth. The occurrence of full moon at the closest point in its orbit will result in unusually high and low tides in coastal areas.

July 17: Mercury, only 53.5 million miles from the earth, is at inferior conjunction—between earth and sun.

AUGUST

August 10-12: Watch the northeast sky for several hours on each of these nights. On August 11, the Perseid meteor shower should reach its maximum rate of nearly fifty meteors per hour (as seen by a single observer).

August 31: Mercury is beyond the sun at superior conjunction, 127 million miles from the earth.

SEPTEMBER

September 5: The second eclipse of the moon this year will occur in the predawn hours today, beginning at 5:36 A.M., EDT. The total part of the eclipse will begin about the time the moon sets for observers at stations on the East Coast. Western observers will see the moon leave the dark part of the shadow—the umbra—at 6:07 A.M., PDT. It will set about three-quarters of an hour later.

September 20: Observers in the United States west of the Rocky Mountains will be able to witness a pa
eclipse of the sun. The eclipse will begin about 4 P.M.,
on the Pacific Coast, and end about 5:50 P.M. Sunset
intervene before the eclipse ends for observers bet
the Rocky Mountains and the Appalachians, while
watchers on the East Coast will miss the event comple
The shadow of the moon will leave the earth at sunset
a point a little east of Roswell, New Mexico.

September 22: The sun passes from the northern
into the southern when it crosses over the Equato
9 P.M., EDT. Autumn begins in the North and spri
welcomed in the Southern Hemisphere on this date.

OCTOBER

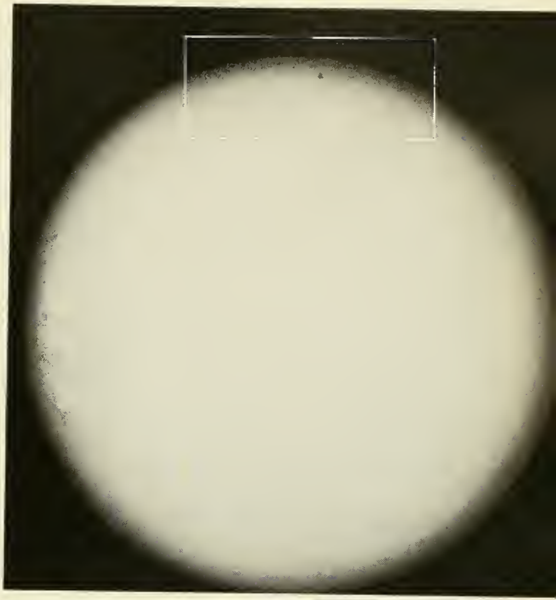
October 9: The moon will pass in front of Aldeb
about 5 A.M., EDT. The bright limb of the moon will
our view of this first-magnitude orange star, in Ta
and the dark limb will uncover the star about an
and twenty minutes later. East Coast observers ma
see the reappearance of the star because, at this late
the sky will already be brightening with the coming d

October 12: The moon is at apogee and last qu
within a period of four hours. This combination will
in an unusually low range between high and low tide

October 30: This Sunday morning marks the en
Daylight Saving Time for many areas of the country
all your clocks *back* one hour.

NOVEMBER

November 7: An unusual astronomical event—a tr
of Mercury across the face of the sun—takes place to
while Mercury is 62.6 million miles from the earth.



Photoheliograph records transit of Mercury (black dot in rectangle, *above*) across the sun's disk, November 14, 1953.

By K. L. Franklin

of the planet will first appear on the face of the sun ich will look about 240 times larger across than will ɔury) at 9:35 A.M., EST. It will leave the western limb e sun at 2:12 P.M., EST. For the West Coast, the transit be in progress at dawn, and end at 11:13 A.M., PST. escope or a good binocular is needed to observe this t, but *do not look at the sun.* Hold the instrument so an image of the sun can be projected on a white piece ıper. A little practice ahead of time will show you to get a fine. large image of the sun. You will probably everal sunspots, which may look about the same size e image of Mercury. Mercury, however, will look ɔer and more purely circular, and it will move obvi- across the face of the sun. (The photographs of ury's November, 1953, transit of the sun, reproduced e, were taken at the United States Naval Observatory a specially adapted telescope known as a photohelio- ı, and may serve as a further guide to the appearance e event.)

VEMBER 12: Observers with small telescopes may to look for Uranus. This distant planet (1,720 million from the earth tonight) will be 2 to 3 degrees north west of the waning crescent moon when it rises. ıs will look like a star of the sixth magnitude.

VEMBER 21: The thin crescent moon, only two days vill present a beautiful sight in the southwestern twi- sky, passing somewhat to the north of Jupiter (−1.5 itude, 555 million miles), Venus (−3.5 magnitude, ıillion miles), and Saturn (+1 magnitude, 995 mil- miles). At the same time, Mars (−1 magnitude, 66 n miles) will be bright in the eastern sky, in the ellation of Gemini.

November 24: Planet-hunters have a good chance to see Mercury shortly before sunrise. It will look like a yellow-white star of zero magnitude, and may be found low in the southeast sky.

DECEMBER

December 3: The full moon will occult Aldebaran about an hour after moonrise for observers on the East Coast. Although Aldebaran is bright, a binocular should be used to observe this event. Otherwise the star will probably be lost in the glare of the moon.

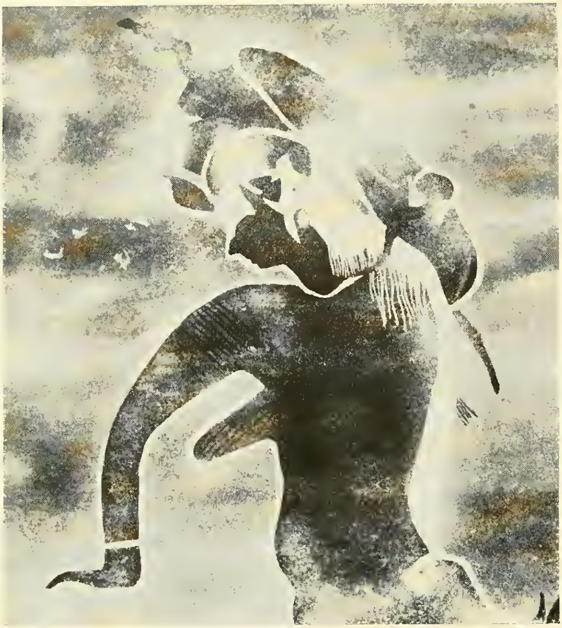
December 10-15: During the late evening and early morning hours of these dates, a meteor shower will be in the sky, appearing to come from the constellation of Gemini. A single observer may see as many as fifty Geminids per hour during the peak, on December 13, at about 2 A.M.

December 21: At 3:27 P.M., EST, the sun will be at its most southerly point in its apparent circuit through the stars. Winter begins in the Northern Hemisphere, and summer begins in the Southern Hemisphere.

December 25: Mars is our "Christmas Star" this year, being closest to the earth—56.5 million miles—today.

December 30: While Mars hovers at opposition—due south in the midnight sky—the moon will again occult Aldebaran in the early morning hours. On the Pacific Coast, this event will straddle the change of date: from about 11:00 P.M., PST, December 29, to about 12:30 A.M. of the following day, December 30.

Dr. Franklin of The American Museum—Hayden Planetarium prepares this summary each six months.

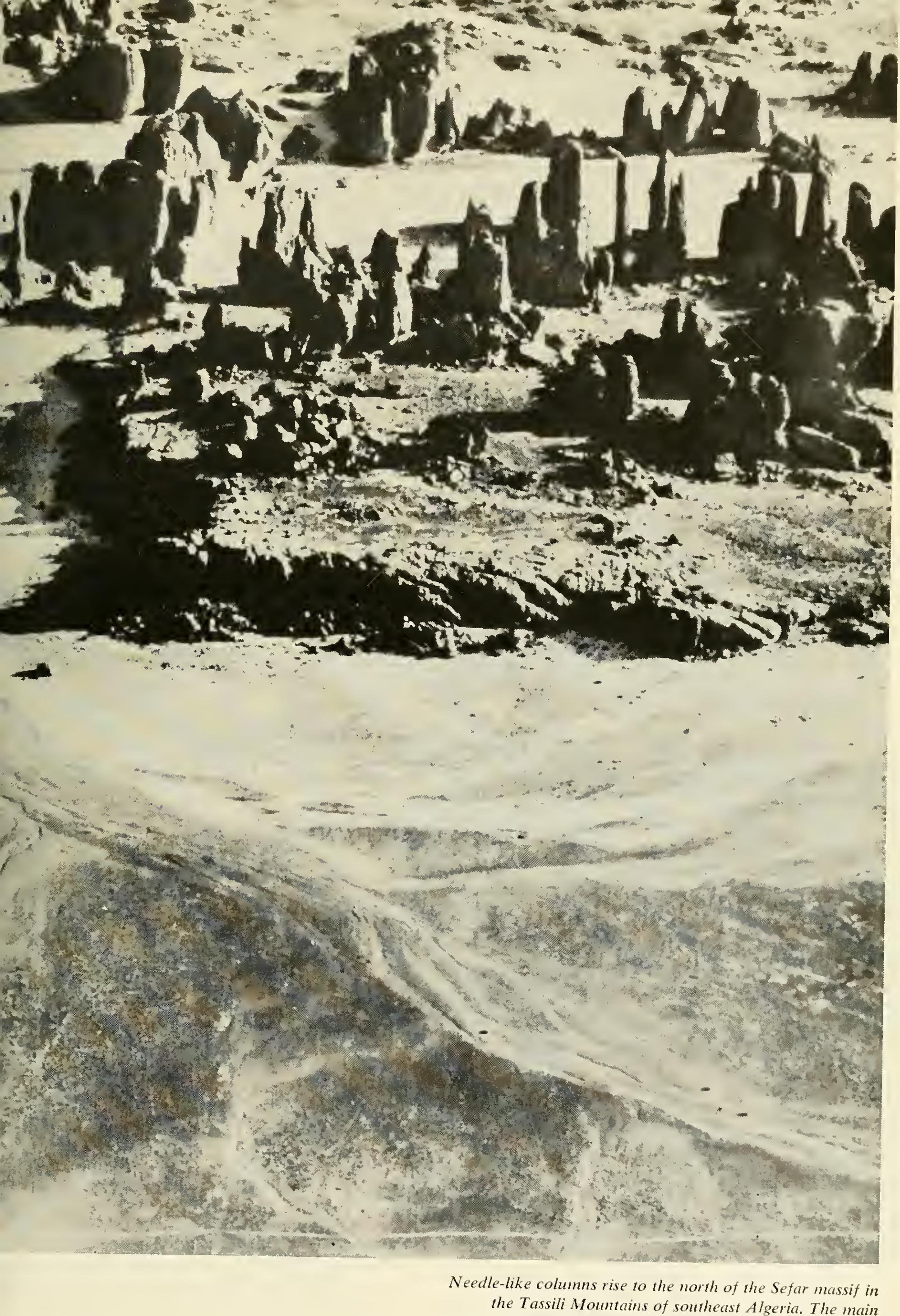


Kneeling woman, about six feet high, is one of the more than five thousand figures painted on rocks at Jabbaren. Elaborate headdress may identify her as a Libyan goddess.

SAHARAN ROCK ART

By Henri Lhote

In 1956-57, Henri Lhote, the French explorer and archeologist, undertook an expedition to the Tassili n'Ajjer massif in the central Sahara Desert. During a grueling eighteen months, he and his companions discovered a vast collection of prehistoric paintings on the rugged Tassili Plateau. Working under severe circumstances, the Lhote party copied these rare works, which reveal previously unknown cultures living in a Sahara that supported wide varieties of animal life. The text given here is excerpted from M. Lhote's book, *The Search for the Tassili Frescoes: The Story of the Prehistoric Rock-Paintings of the Sahara,* translated from the French by Alan Houghton Brodrick and copyrighted, ©, 1959, by E. P. Dutton & Co., Inc. The illustrations are also from M. Lhote's book.



Needle-like columns rise to the north of the Sefar massif in the Tassili Mountains of southeast Algeria. The main axis of the Sefar is a canyon, cut by gorges in the sandstone.

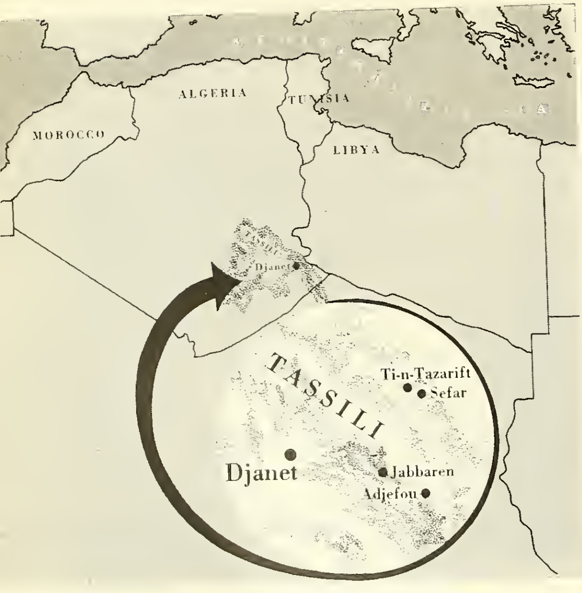
ANCIENT MAN AND HUNTED IN

THE SAHARA DESERT (especially in the south of the Algerian province of Oran) contains a great number of prehistoric rock engravings, but it was not until 1933 that it was revealed as an area also rich in rock paintings. These discoveries were the more exciting since we knew really very little about the great desert's past, although signs made us think that the Sahara might have had a more abundant rainfall in the past than at present. Also, stone artifacts, found here and there, proved the existence in far-off ages of primitive populations and tribes. Nevertheless, the information, such as it was, could only be called fragmentary: we knew nothing of the nature of those populations.

For many years past I have devoted my life to scientific exploration of the Sahara. I have traveled all over it, and I have studied it from the points of view of geography, ethnography, and, above all, archeology. The Saharan rock engravings and paintings could not, of course, fail to excite my curiosity. After important discoveries of painted rocks had been made in the Tassili by a *méhariste* officer, Lieutenant Brenans, I visited the Tassili sites in company with several specialists in Saharan geography and archeology. Then came World War II and, of course, it interrupted all my work. It was n until 1956 that I was able, with the encourag ment and the support of the famous prehistoria the Abbé Breuil, to organize a large exped tion with a view both to copying the paintin already known and also to exploring, in a sy tematic manner, the whole of the Tassili mou tainous mass.

The Tassili n'Ajjer (map, *lower left*) is sandstone plateau, difficult of access. It for the base or platform from which rise a conside able number of small, secondary massifs— heavily eroded. Through them one can make way by means of narrow corridors, overhung cliffs, and of pillared areas that remind one deserted cities. Today, all this region is em of life and an oppressive silence hangs he over everything. Once upon a time, however, passages were streets lined with habitatio most of the cliffs are eroded at their bases thus present rather deep shelters that provi natural homes for the early inhabitants of region. These peoples have, it is true, long si disappeared, but they left hundreds of painti on the rock walls of their former dwellings.

OUR expedition stayed sixteen months i on the Tassili. What we beheld among maze of the Tassili rocks altogether baffles imagination. We copied hundreds and hund of painted walls on which were depicted hu and animal figures in their thousands. Som the figures stood alone, others formed com assemblages. Sometimes the scenes were enough and related to everyday life or to spiritual and religious existence of the diffe populations that succeeded one another in that are now, to all intents and purposes serted save for the very few Tuareg who haunt them. Side by side with little figur very few inches high, we came across othe gigantic dimensions such as are unkown ar prehistoric pictures elsewhere. Then there w be archers struggling for the possession of f and herds, figures of warriors armed with c of hunters chasing antelopes, of men in ca hunting the hippopotamus. There were c scenes, representations of libations, and so



Expedition to southeastern Algeria covered Tassili area, shown in detail in inset. Place names indicate the sites of some of most important discoveries.

IERDED OXEN
/ERDANT WILDS

Although the cave paintings of France and
ain have revealed to us something of the man-
rs and customs of the Paleolithic peoples of
irope, these have not taught us much about
character or the origin of the artists—except
it we do know that, at one time, France was
iabited by men who hunted bison, mammoth,
inoceros, and reindeer. However, if it be com-
red with our prehistoric European art, the
ssili art constitutes a mass of documentation
t allows us to form a clear idea of the ancient
pulations of the Sahara—of the different types
peoples that swept over the desert in succes-
e waves of pastoralists. We can also note the
eign influences that made themselves felt.
ain, thanks to the Tassili pictures, we can
ow the changes in the fauna and, thus, of
climate, and trace the progress of the desic-
ion that was to culminate in the pitiless desert
t is known to us today.

HE engravings and paintings in the Sahara
seem to fall into four main periods:

e: That of the hunters of the *Bubalus*—that
vild buffalo (early Neolithic?).

o: That of the "Bovidian" cattle pastoralists
olithic).

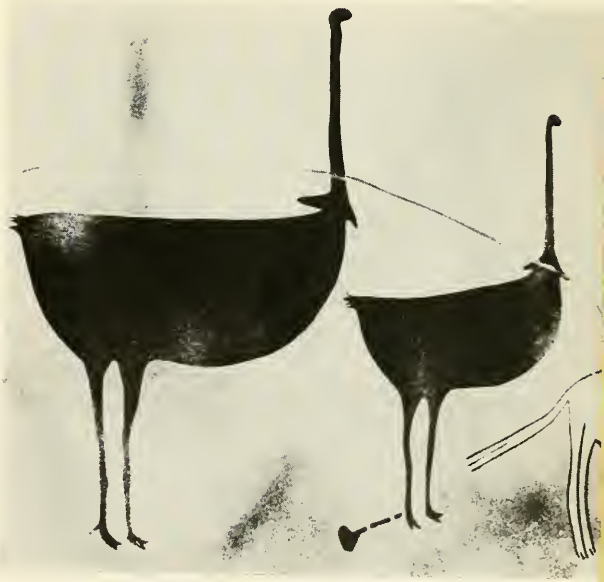
ee: That of the pastoralists with chariots
cavalry—the so-called "Equine Period"
otohistoric).

r: That of the camel (dating, more or less,
the beginning of our era).

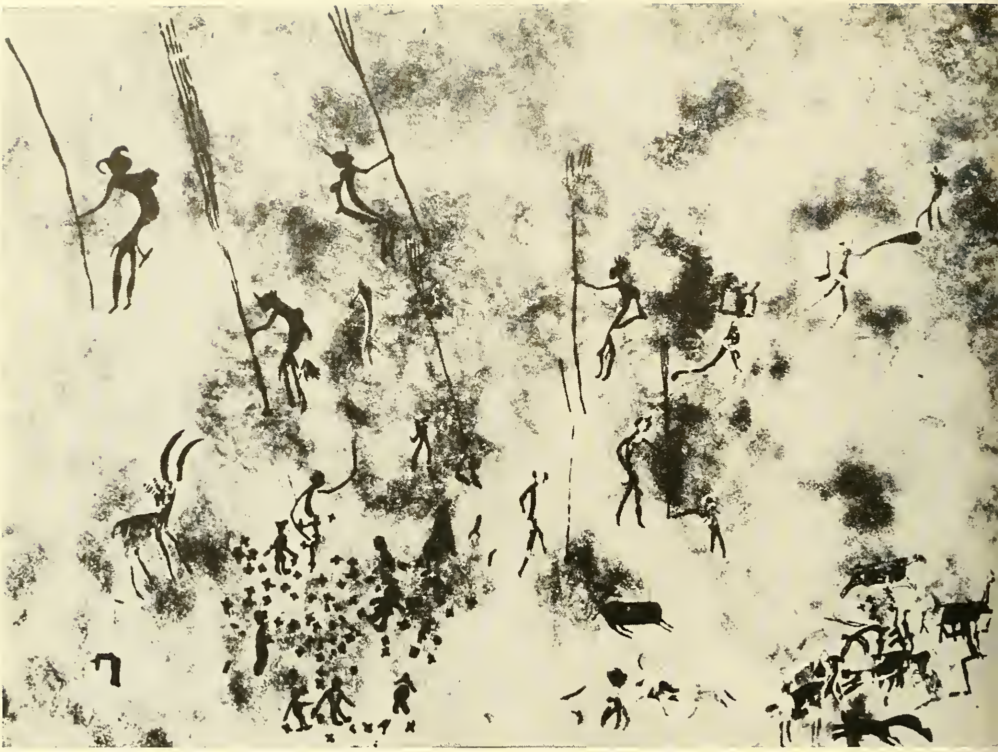
ach phase, of course, presents its own prob-
. For the present we must be satisfied with
neral summary that, I would stress, is sub-
to revision—a summary based on the evi-
e as it appears now, presented by overpaint-
and various art styles.

he first of these periods may be called that
ie "Round-headed men." It seems that the
ancient paintings in the Tassili are those
nall human figures with schematic bodies
round heads, all painted in ochre. The
s, moreover, were always exaggeratedly
. The arms are variously depicted, but often
(indeed, generally) they are reduced to mere sticks. There are also to be noted in these paintings bows and a sort of lance or pitchfork about half again as high as a man (illustrations, page 32). There is no "scene" that can be interpreted as such, and animals are uncommon—when they do occur, they are mostly elephants and various kinds of wild sheep.

THE appearance of polychrome paintings marks the start of the next major phase. The style is still that of the Round-heads, but the figures are of larger size and are better treated. The artists have now come to take more and more care in the representation of their subjects, which includes not only human figures but also those of elephants, rhinoceros, *Hippocervidae,* and wild sheep. The artistic quality improves all the time, forms become more graceful and great attention is paid to details. Bracelets or anklets can be identified and there are belts, hair or shoulder ornaments (for example, feather headdresses). Markings (very numerous) on the breasts, belly, thighs, legs, or arms may be interpreted either as scarifications or painted designs. The marks, made up of regular lines of dots, recall very forcibly those still to be

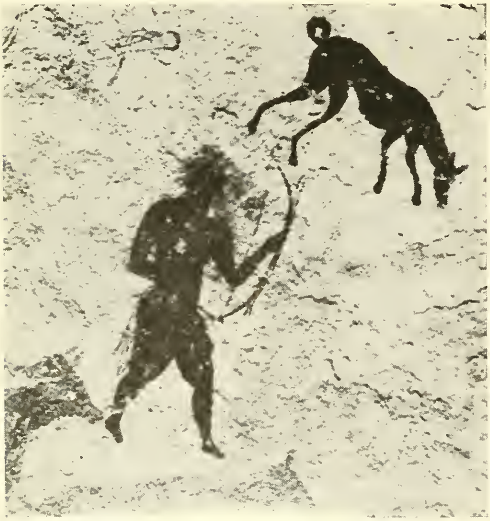


Detail of fresco at Adjefou "wadi" shows ostriches in red ochre. They are probably of the "Round-head" period. Overpainting of feline is not as old.



Hunters carrying trident spears—perhaps used to take birds—were found at Sefar, and may be Neolithic. Crosses at bottom and figures at right are of later date.

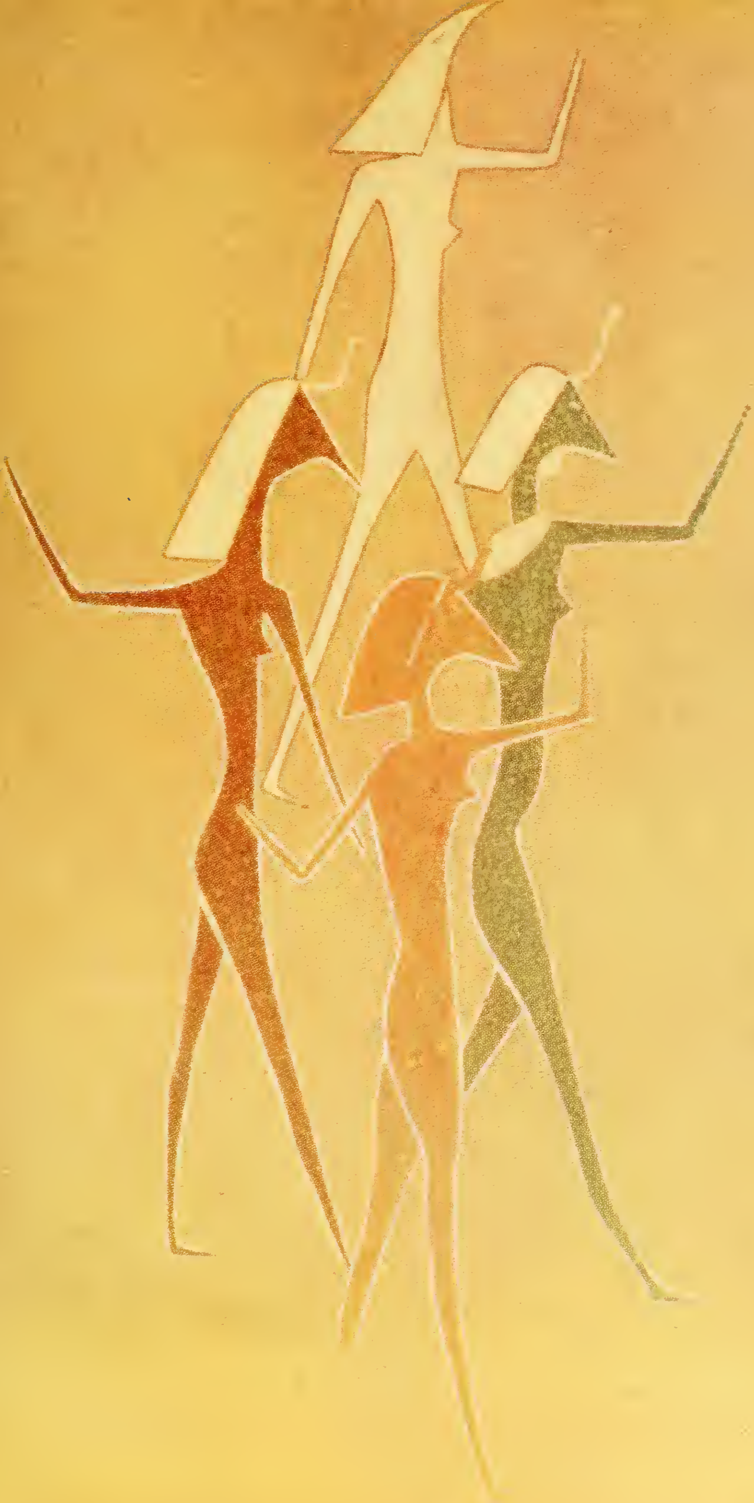
Bird-headed goddesses at right, from Jabbaren, are l
those on Eighteenth Dynasty Egyptian monuments
about 1200 B.C. This fresco is only fourteen inches hi

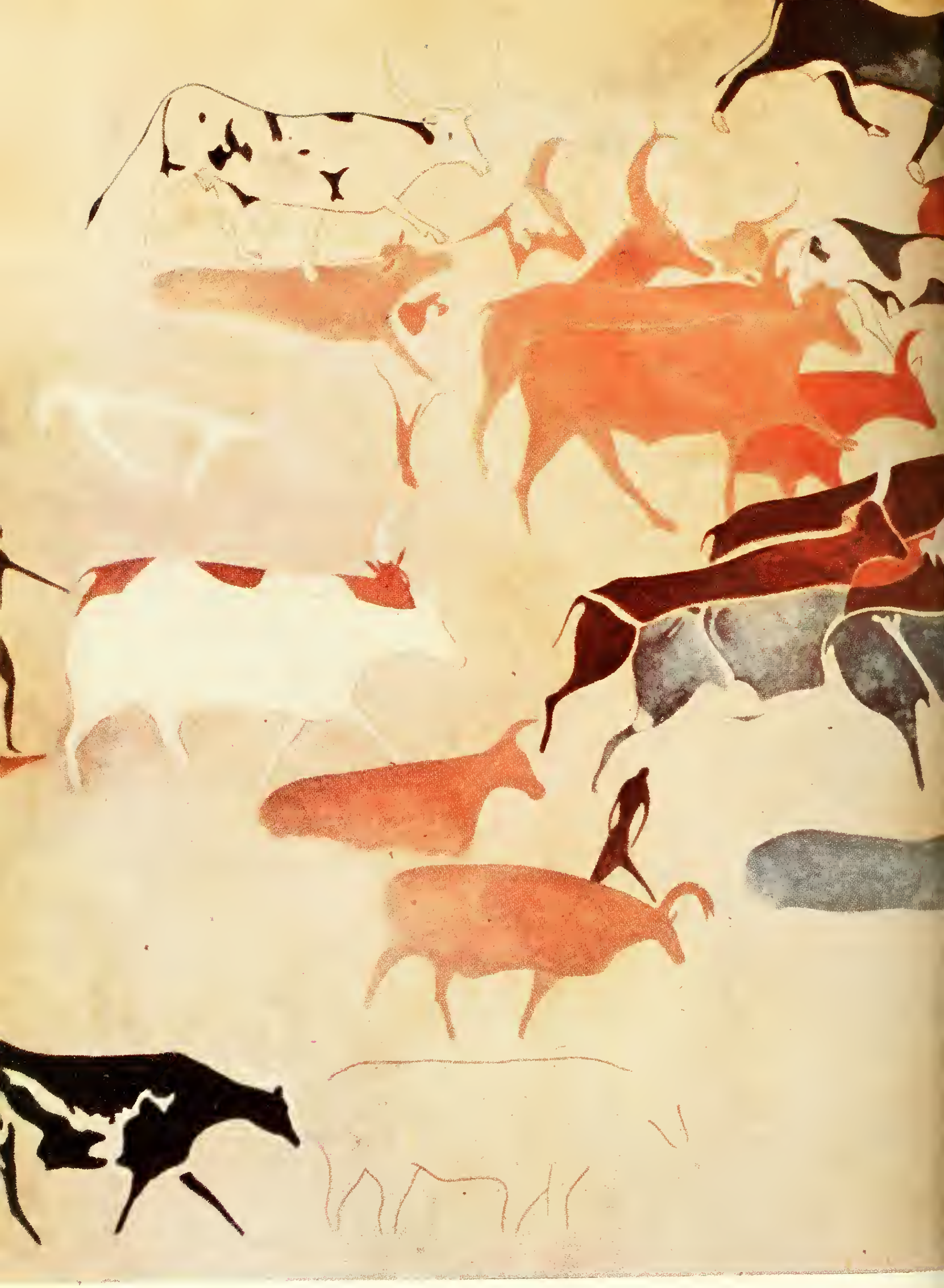


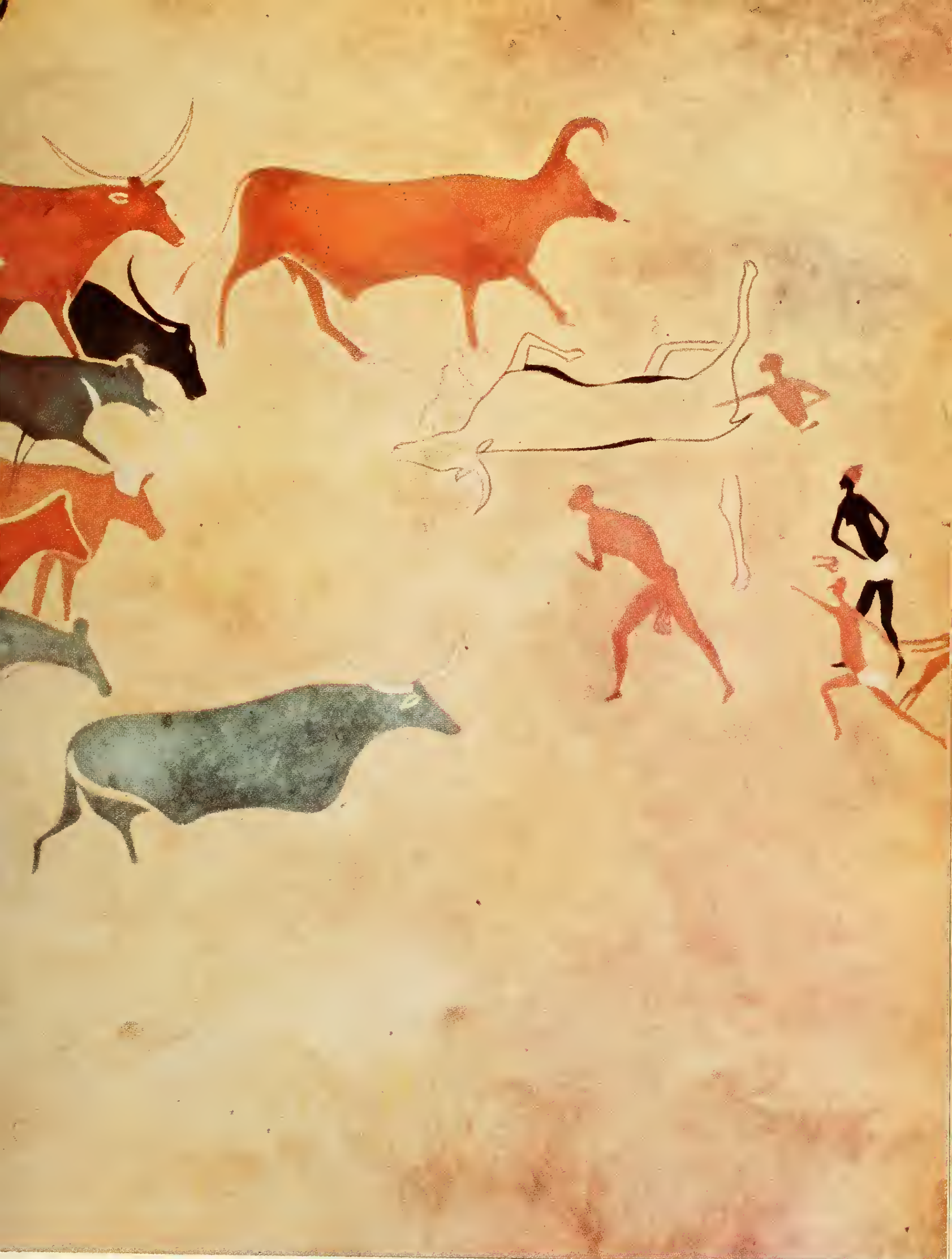
Hunter, with bow and arrows, is accompanied by a short-tailed dog, rare in "Bovidian" period paintings. This photograph of rock face was taken at the Sefar site.

seen among the populations of the Upper Nile or Central Africa. This evidence is valuable and new, especially as we still know nothing as to the origin of the Negroes or about the period when they occupied the African continent.

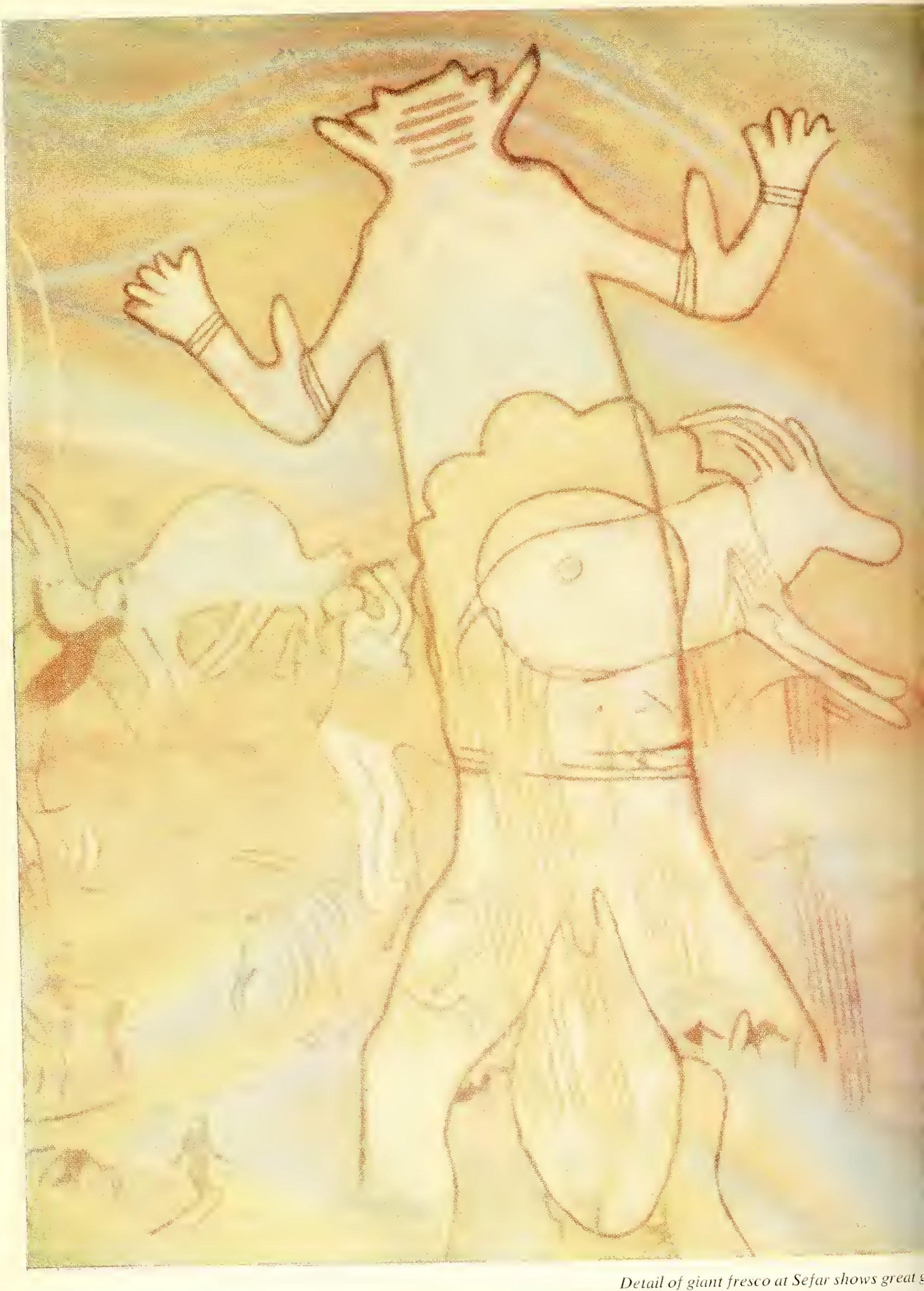
At the end of the Round-head period—at a date that cannot be fixed precisely—there was an obvious Egyptian influence in the Tassili and this influence is clear in several works of an exceptionally high quality. The new art tradition mingled with that of what I shall call the "Negroid" substratum and gave rise to quite original paintings. Outstanding is a group of figures of which our "Antinea" (page 28) is the most remarkable. This magnificent painting was found in a low-roofed shelter where the picture is difficult to view. It is, indeed, curious that a work of such high quality should not have been put in a more prominent place. The woman, with her straight nose, indicates a Mediter-



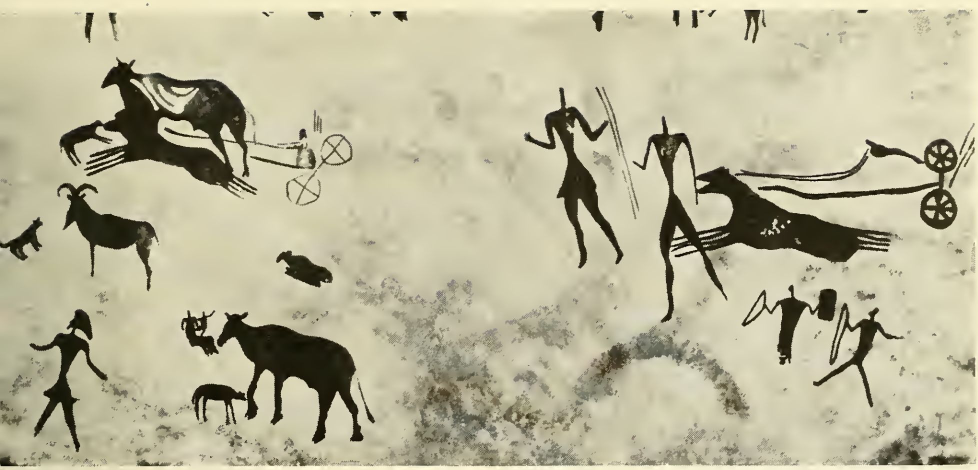




Oxen and herdsmen were first engraved, then painted on rocks at Jabbaren by Neolithic artists. Fresco, about five feet long, reveals today's desert as a once-fertile grazing land.



Detail of giant fresco at Sefar shows great g
nearly eleven feet high, with suppliant women. Antelope pair
over god is, in turn, overlayed with a scalloped des

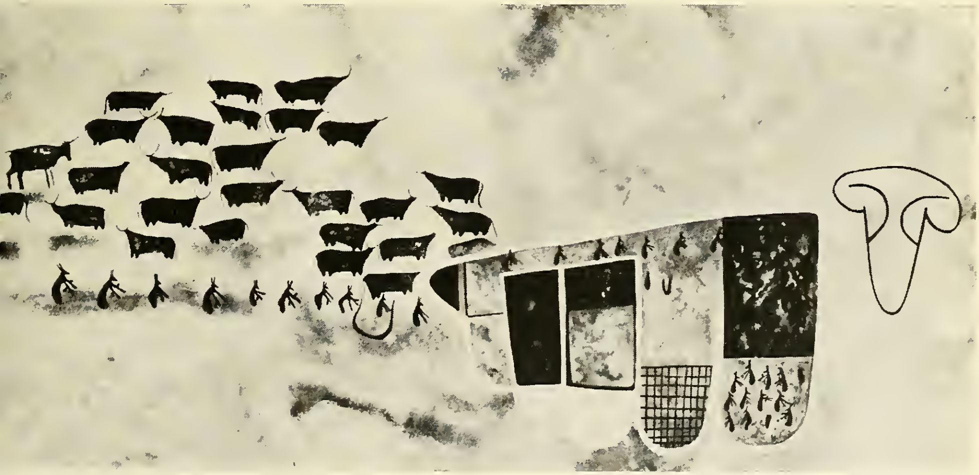


Protohistoric drawings at Adjefou depict thin, stylized, "bi-triangular" men with javelins. Both the chariots and the shield-carrying archers are apparently earlier in date.

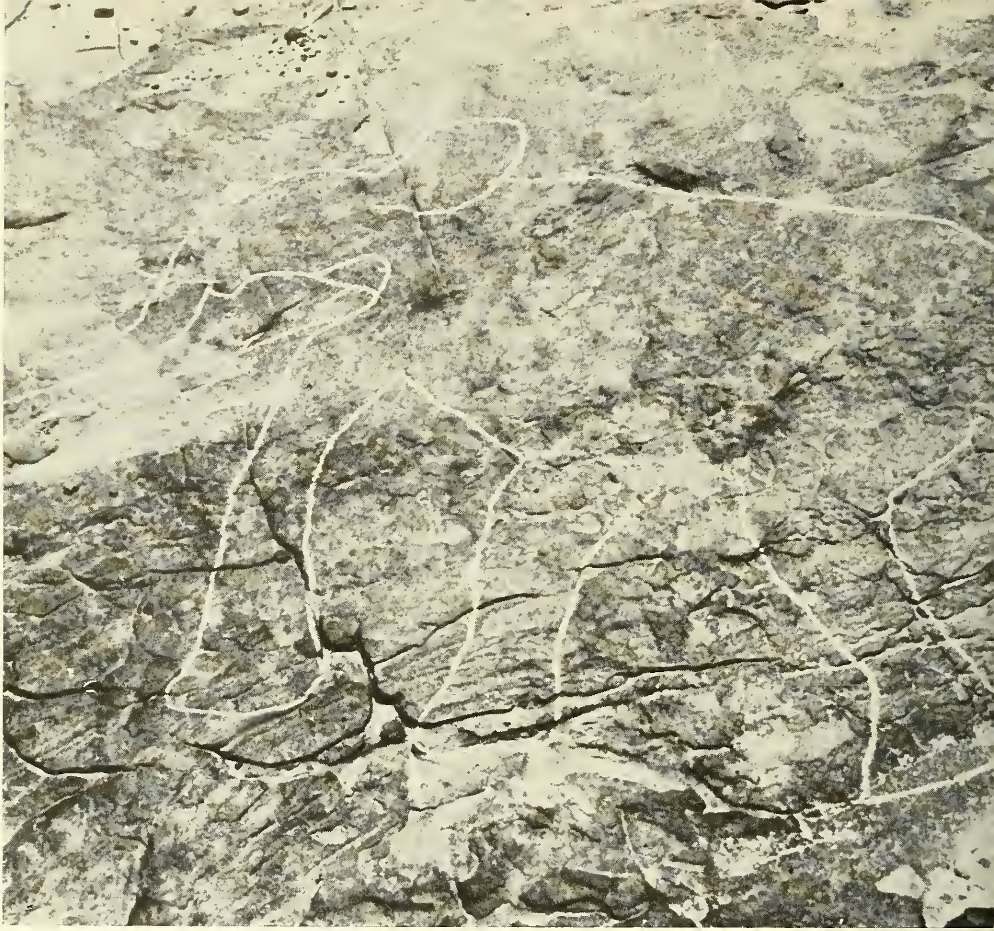
ranean influence, although some Egyptian features can be noticed.

What seems to be the final phase of the Round-head style is, compared with the other art phases in the Tassili, obviously decadent from the aesthetic point of view. The drawing is coarse, the forms are heavy, and there are no carefully executed details. Gigantic size is the characteristic of this phase and one gets the impression that the artists were more concerned with making their pictures imposing than with striving for the beautiful.

For instance, we found on one wall—where it reached from the ground to the roof—a human figure measuring about fifteen feet in height. If we take into account the lower part, now much effaced, it must originally have been over eighteen feet tall. This figure holds the record for being the largest prehistoric painting in the world. In addition to the human figures, this



Cattle with foreshortened legs and heads are remarkably modern in style. Legless, eared figures seem to be engaged in a ritual dance. Five-lobed design is not yet explained.



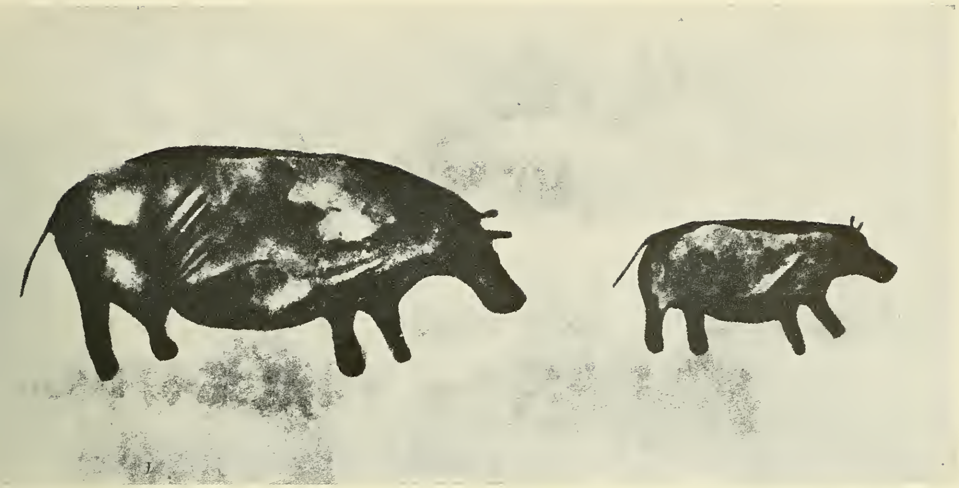
Elephant, engraved on rock, is perhaps the most ancien all Tassili discoveries. Photographer filled in lines with chalk to make animal's outline more easily visil

phase includes numerous animals, which give us a good idea of the variety of the fauna then existing in the Sahara: elephants, giraffes, wild oxen, *Hippocervidae,* wild sheep, wart hogs, lions (one of the feline paintings is over twelve feet long), and ostriches. Certain of these animals may, perhaps, have played a magic role, for they are often found in association with women whose arms are raised in an attitude of adoration or supplication. With this "decadent" phase the great period of the Round-head paintings comes to its close.

Soon the Tassili was invaded by newcomers, who in no way resembled their predecessors and who pushed herds of slow-moving cattle before them into the upper valleys. The walls of the Tassili shelters were to be covered with pictures in a new style and of an entirely new tradition.

THESE new paintings consist of human and animal figures of small size, treated in an admirably naturalistic way. When we look on the enthralling assemblages of this Bovidian (that is, cattle herder) period we must, I think, conclude that they represent the greatest naturalistic school in the world. Living creatures are caught in movement, seized by the artist as they exhibited their most lively attitudes and reproduced with a fidelity and a vigor that attest to an incomparable acuity of observation (illustration, pages 34 and 35).

Cattle are favorite subjects of these artists. It



In hollow at base of rocks forming natural amphitheater in Ti-n-Tazarift massif, these Neolithic hippopotami seem out of place today, surrounded by waterless wastes.

clear from the number of the oxen and from e artistic quality of their representations that ese beasts occupied a place of great impor- nce in men's lives. They are fine creatures with he and active bodies kept fit and trim by graz- g about over the savanna-like steppes. There e no signs of the masses of fat induced by a dentary life in enclosed pastures. The cattle ve long horns—either in the form of a lyre or that of a semicircle—and the horns seem to ply the presence of two different species, well own in dynastic Egypt—the African ox or s *africanus,* and the *Bos brachyceros* or thick- rned ox. The animals are presented either in t tints or in outlines, and are generally shown large herds, followed by their herdsmen.

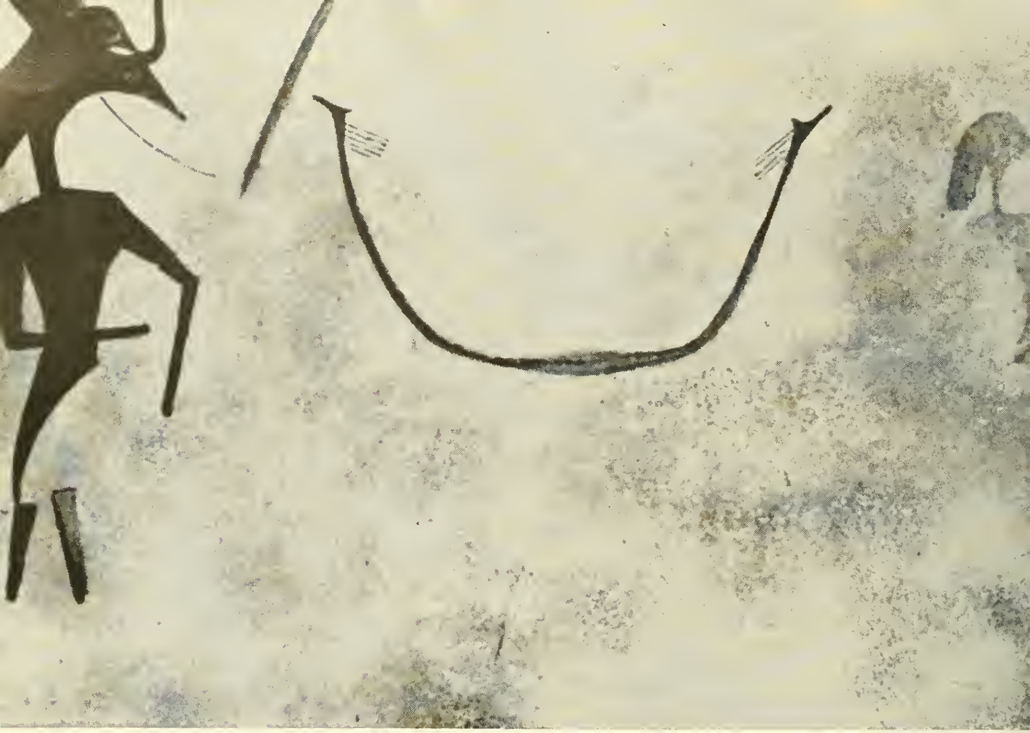
WILD animals are treated no less skillfully, and the Bovidian pastoralists, who were so hunters, left for us a whole menagerie at gives a clear and accurate account of the pical fauna that formerly inhabited the hara—elephants, rhinoceri, hippopotami, raffes, *Hippocervidae,* gazelles, aardvarks, ns, wild asses, ostriches, fish, and unidentified uines. Such an abundance of wildlife implies e existence of a very damp climate and rich stures—which is further proved by a fresco hippopotami being chased by men in a canoe.

Both beasts and men are shown grouped as life. One sees human figures in the midst of oval that seems to represent the ground plan of an oblong hut: the door indicates clearly the materials used for its construction—straw or esparto. In fact, just the same sort of hut—made of vegetable matter and standing on a foundation of pottery—is to be found today in all the French Sudan. In other paintings one may see women standing before their cooking pots, men with axes in their hands ready to split wood, children lying under a coverlet, people sitting in a circle, conversing, and many other scenes that reveal the material life of these pastoralists, who, moreover, must already have practiced some sort of agriculture, as is indicated by a group of women tilling a field.

The origin of these pastoralists would have been mysterious enough had we not discovered decisive evidence that they came from the Upper Nile. Indeed, in six different sites we found Bovidian pictures in which were representations of typical Egyptian boats with the standards of the nomes—the ancient provinces of Egypt—at the prow. The really extraordinary fact that such characteristic paintings exist on the Tassili rocks proves that these pastoralists had, at one time, contacts with the Valley of the Nile and that, in all probability, they came from the east.

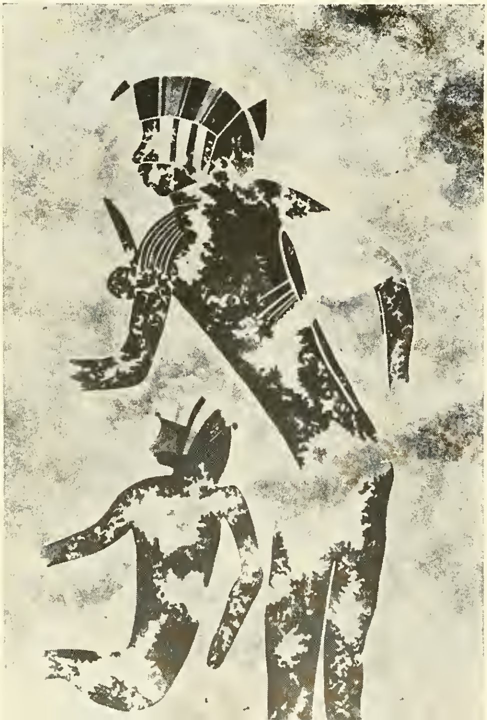
Such, then, as I see it from my first attempts at interpretation, are the main art phases that can be distinguished in the Tassili frescoes. But there are other paintings that we have not yet been able to place chronologically.

One of the most unexpected of our discov-



Jabbaren fresco, above, was on unsheltered
Again, Egyptian influence is obvious. The headdre
the men's loincloths, and the skirts of the women ar

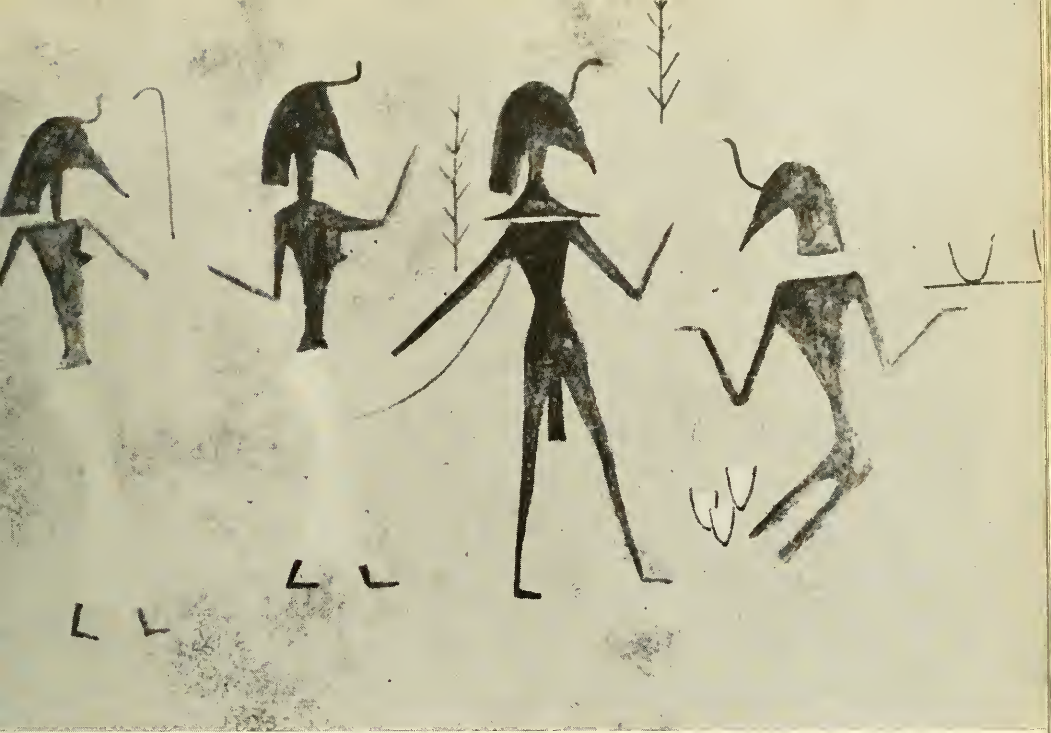
Strong Egyptian influence is apparent in the painting, below, at Sefar. Gray-blue, red ochre, and white pigments, now worn by the elements, resemble those used at Jabbaren.



eries was that of two typically "Egyptian-style"
paintings at Jabbaren. The first shows four tute
lary goddesses with birds' heads (illustration
page 33). This is clearly a scene of offerings
shown above. The two are the only examples o
their kind that we came across and they presen
a puzzling problem, for no one, up to now, ha
suggested that the Egyptians penetrated as fa
to the west of the Nile as the Tassili.

"Horse" and "camel" period pictures, whic
fall into historical times and are well represente
on some Saharan sites, were, comparativel
speaking, not numerous in the region we pros
pected. We did, however, come across a fe
pictures of chariots.

THE discovery of the first Saharan representa-
tions of chariots provoked much excited dis-
cussion among archeologists years ago. Wh
could have drawn such things and what did the
signify? Was it possible that once upon a tim
chariots had been driven through the Sahara
Herodotus mentions a people belonging to th

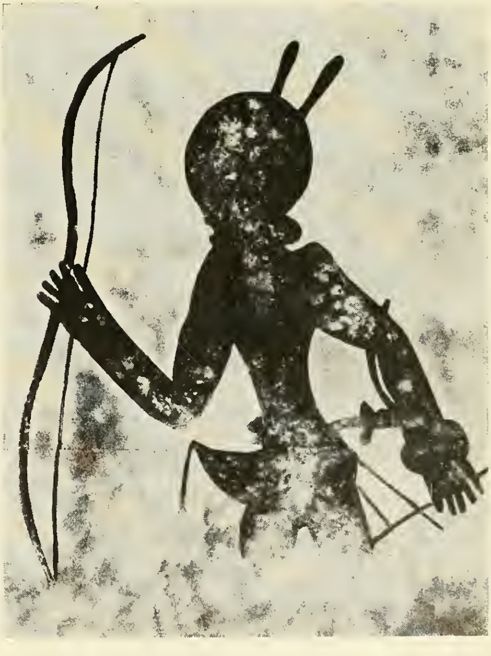


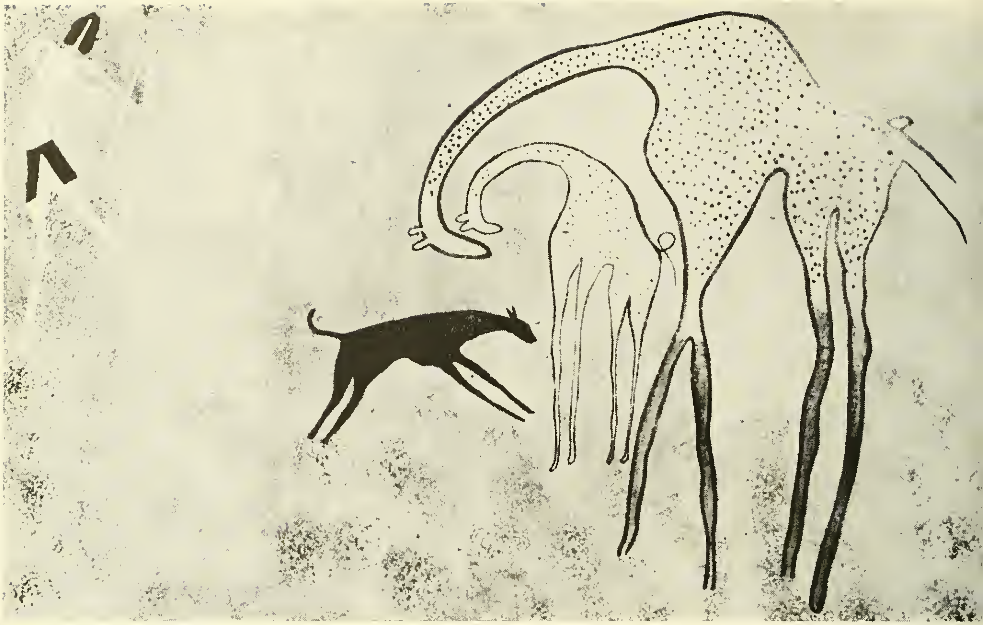
l of the Eighteenth Dynasty, while the conical are similar to those of Predynastic Egypt. The ritual left, is like those found in Upper Nile area.

eat Libyan nation, the Garamantes (whose nd lay in what is now the Fezzan), saying they ed in war two-wheeled chariots drawn by two four horses. With these vehicles the Garamantes pursued another Saharan people, the roglodytes," who lived in caverns and rock elters. Since Herodotus died about 425 B.C., e events he related would have occurred in the h century before our era.

The Saharan chariot pictures were thus, first all, attributed to the Garamantes of Herodus. But a careful examination of the paintings as made by such experts as Dussaud and Salon Reinach, who concluded that the very culiar style of the horses—galloping with outretched legs (illustration, page 37)—was one early related to the "flying gallop" convention the Mycenaean art of Crete. Now, it is certain at, about 1200 B.C., immigrants from Crete nded in Cyrenaica with the object of conquerg Egypt, and that these people mingled with e Libyans. So it appeared that the Saharan ariots must be more ancient than has been

Archer of "Evolved Round-head" period, below, is detail from gigantic fresco. Figure, rendered in light yellow ochre, shows possible feather headdress and heavy bracelet.





Large giraffe protects its young from an attacking dog as archer draws back his bow for the kill. Spirited painting is from the "Equine" or protohistoric period.

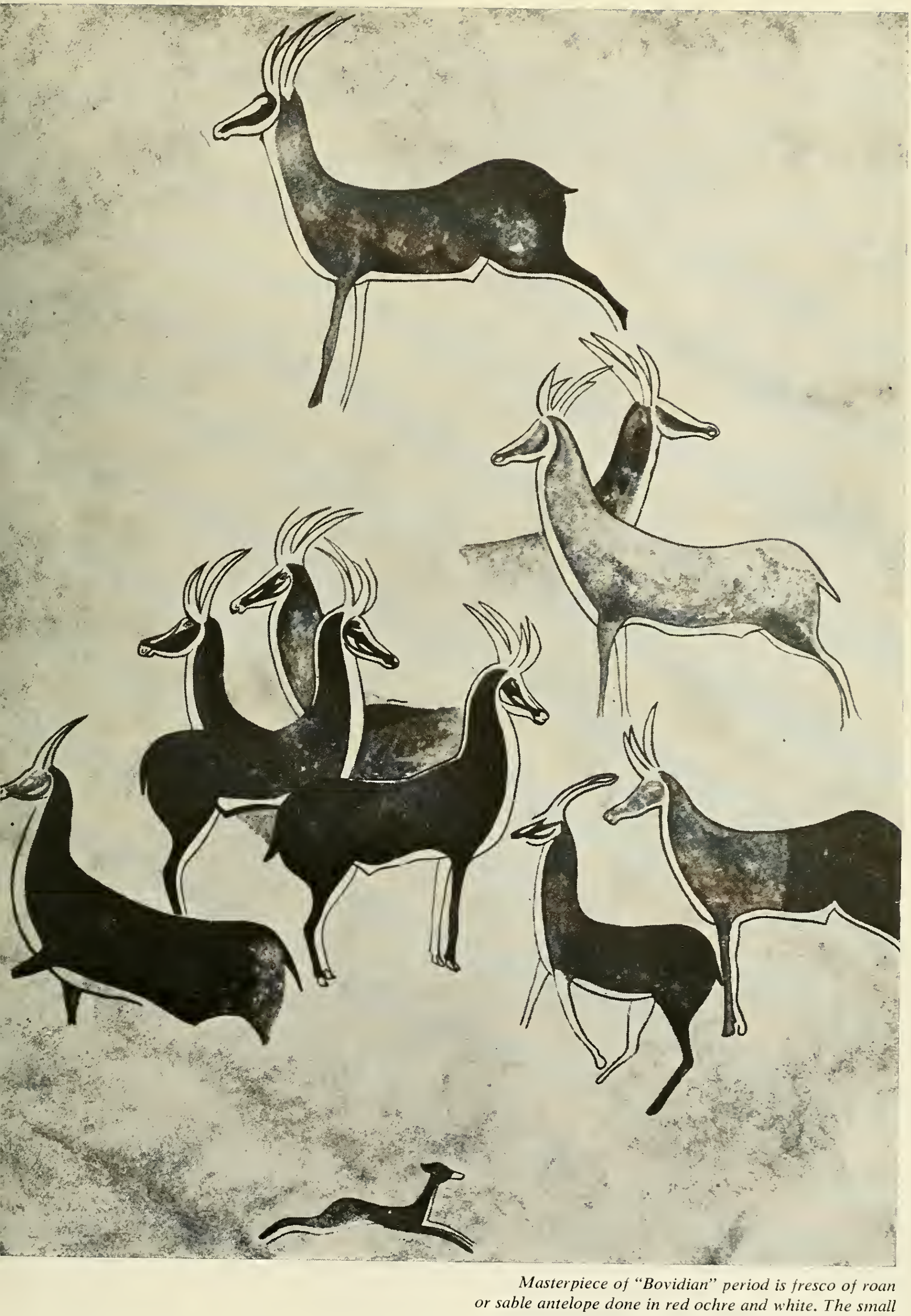
supposed and they confirm what historians had called (borrowing words from ancient Egyptian texts) an invasion by the "Peoples of the Sea." It might well be that after the failure of their campaigns against Egypt these invaders of Cretan origin retired toward the Saharan regions, where, sooner or later, the Peoples of the Sea interbred with their Libyan allies.

As well as copying the paintings of the Tassili, we sought for traces that the astonishing populations of artists might have left near their works. We were able to find a considerable number of grinding stones and pestles. In certain shelters, bits of pottery literally covered the ground. I did some digging at the foot of painted rock walls and, in several places, found abundant remains of grain mixed with objects identical with those on the surface—not only the same grinding stones and pestles and the same pottery, but also stone axes, flint projectile points, scrapers, and ornaments such as necklace beads cut out of ostrich eggshell and schist pendants and bracelets.

All these objects had been abandoned, it seems, by the Bovidian populations. Charcoal was recovered from among the ashes, and when it has been submitted to radiocarbon tests we shall have a good idea as to the date of the Bovidian paintings. Provisionally, however, they can be assigned to about 3500 B.C. That would be a rough dating for the arrival of the pastoralists, but they must have sojourned long in the Sahara—perhaps thousands of years.

The other pictures—belonging to the various phases of the Round-head type of art—are much more ancient. Their very first stages must be assigned to a Neolithic without grinding stones or pottery, whose principal implements were coarsely chipped stone axes. If we date these paintings to about eight thousand years ago—and thus to the very early Neolithic—I think we shall be within the bounds of reason.

PERHAPS in this short summary I have indicated the considerable amount of new information that the Tassili rock paintings add to our knowledge of the Sahara's past. Of course, the close study of our documentary evidence has hardly yet begun. What I have done here is to present somewhat fragmentary data as I collected it on the spot—data that, however, the careful and exact laboratory work of today will, we hope, make more illuminating in the future.



Masterpiece of "Bovidian" period is fresco of roan or sable antelope done in red ochre and white. The small leaping gazelle at bottom is painted in yellow ochre.

er calls from a maple grove's glade.

Skunk cabbage spathes pierce April's floor.

hild's-Eye Woodland

e very young touch and learn in spring and summer woods

By John Hay   Photographs by Arline Strong

HAT DOES A WOODLAND MEAN to
most of us? A complex com-
y of plants and animals. A vaca-
ot. An unspoiled area threatened
housing development. Exploit-
ees. Perhaps these are its mean-
adults: but for a child who has
rned to look at nature in terms
er a predatory civilization or
lytical problem, a woodland is
at it should be—inviolate, new,
ch in matter for the senses. It
en be full of fearful fascinations
—I remember being on the lookout for wolves and more than once hearing owls where they were not!

In these pages, Arline Strong has followed the world of woods and children from early spring on into high summer. Her pictures catch at the unexpected, seize the sensations of sun and shade, document experiences of touch and sight, and relate moods of pleasure, solemnity, questioning. Adults may overemphasize or overuse the word "fun" in considering childhood experiences. For youth is also a solemn-faced, serious business. These young investigators of life are gathering material for the future. Each of their encounters leads to others, in the way the season itself progresses from dormancy to active life, from spring's first few to summer's abundance.

Mr. Hay, President of the Cape Cod Junior Museum, here comments on woodland portfolio of **Mrs. Strong**, photographer of children and nature.

ramed brook is swift and chilly.

iy grass tickles a summer girl.

WHAT does a wood, its clearings, and surrounding fields, provide to children? Trees, water, grass, leaves, insects, nooks and crannies, petals and seeds for games that have to do with tests and wishes, and a home for their feelings. Grass tickles and pleases, or it can be chewed with gusto. Sunlight dancing through an open glade is warm and inviting. They stir up insects as they walk, grasshoppers, leaf hoppers, lacewings. Butterflies dance away from sun spots on a log. Their hearts jump when a rabbit suddenly bounces across a clearing ahead of them, heading for the safety of a thicket. Blue jays scream. A woodland is full of exciting company.

A loosestrife flower in a briar patch must be sniffed.

Does he like butter? Buttercups will prove it.

It's a very lovely toad. Should I take him home?

A little boy stops a minute to at a skunk cabbage. earl spring before the great. green le unfold. It is in the form of a ro open bud—leathery and colored g with streaks of red. A bit like a tu legs. perhaps. Adults might tell that this is a "spathe." which enc the skunk cabbage's flower. and it also serves as a trap for insects

Or a boy will find a toad, a animal. a strange and cool. pu creature whose popeyes stare ahe nobody knows what. He holds his hands. Will he decide to ta home in his pocket, or to let it

No, I guess not. He has his own hom

The caterpillar feels furry—and seems friendly.

Do it in on
and a wish comes

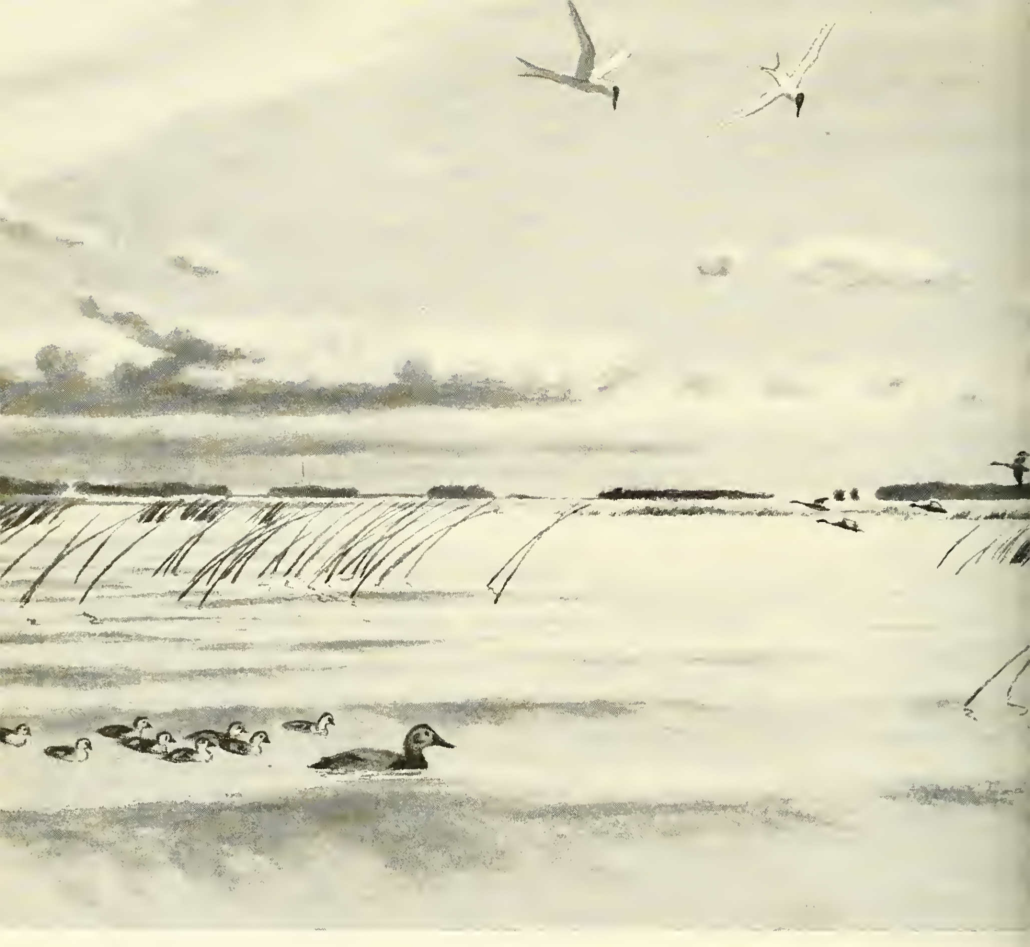
Tent caterpillars have come to live in this wild cherry tree.

The caterpillar
a stick as much as my

Sunbeams, as well as
may be trapped in spider

THEY look. They run on. They wait and see. They pick things up to feel. They touch the hairs on a caterpillar, the silk threads in a spider web. Why the spider doesn't get mixed up and lost in his own home is hard to see. What is this, or that? Children may know only a few names or reasons, but they are nevertheless the freshest witnesses alive.

Boys and girls may be playing their own games when they run off to woods and fields, rather than the game of natural history as it is defined by its students. But what they meet, and what meets them, is part of the same world. Life everywhere, through sun and shadow, in motion and repose, is well received in their own growth.



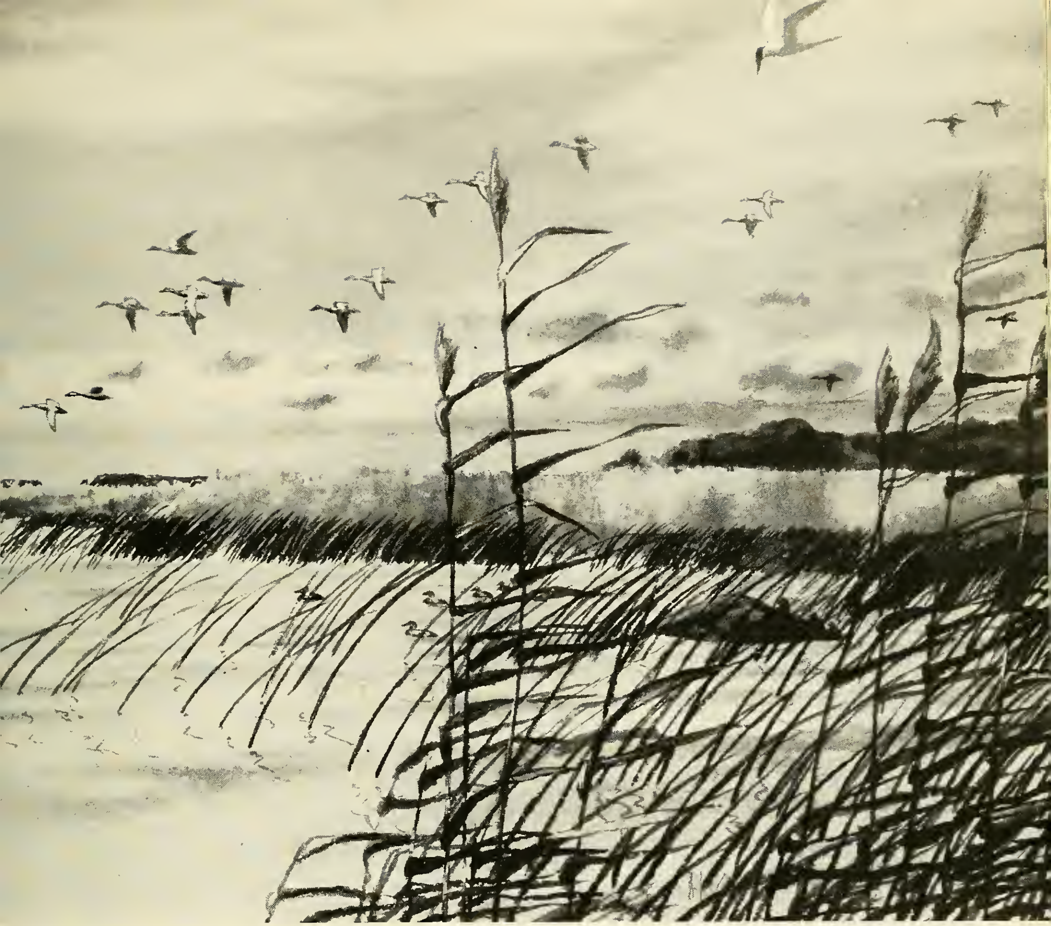
The Brood Season

Brief care and early desertion are canvasback ducklings'

By H. Albert Hochbaum

Lake Manitoba, in central Canada, is a great, shallow pool in the bed of the long-vanished Lake Agassiz, of glacial times. Each spring, for countless years, the north winds have whipped across this open expanse of water and thrown broken ice against the shoals of the southern shore lines, casting up a low, narrow ridge of sand. The ridge, now, is covered by a tangle of poplar, maple, ash, and willow. Behind these woods, extending to the south, east, and west, nearly as far as the eye can reach, is a sea of Phragmites — tall, plume-topped, yellow cane — that ends at last by the far-off groves that mark the farm bluffs on the wheatlands of the rich Portage Plains. This sea of yellow cane is what is known as the Delta Marsh.

New, green life comes to the D
Marsh in early June. Then, the
snowdrift has melted from the dee
maple clump, and the wooded ridg
alive with greenery. Ice has long g
from the bays, and the dead, bro
bulrushes are hidden by new, bl
green growth, broken here and th
by apple-green patches of cattail. T
Phragmites beds are knee-deep



G **TERNS observe the arrival of ducks that breed in**
ing among the cattails and yellow cane of Manitoba's

Delta Marsh. Some early birds, *left*, have hatched broods, but canvasback young usually do not appear until late June.

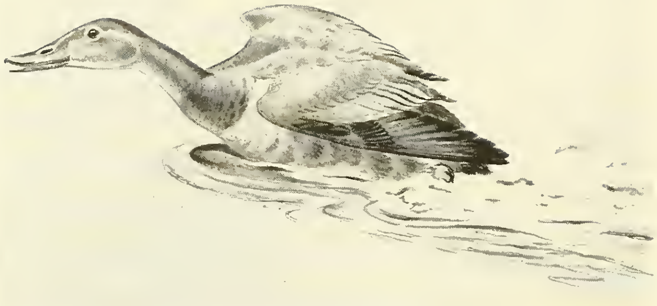
but the tall yellow canes of the
us year will not be hidden by
v growth until July. Early June
ta is not spring, nor is it yet
er. It is a brief period of in-
en, when the life of the marsh
any characteristics of both sea-
Traveling over the bays. one still
arties of redheads in prenuptial
hip, and still finds courting
s of gadwalls. blue-winged teal.
ers, and lesser scaups. The first
winged scoters are just starting
. A few bands of whistling swans
ot yet started north.
there are signs of summer. Loaf-
rs are crowded with mallard and
l drakes, already wearing their
e plumage; even now a few skulk
ing and flightless—in the reeds.

There have been broods of mallards and pintails afloat for two weeks past; and now one may look for the first canvasback and redhead broods.

Each year, the first canvasback ducks hatch at Delta about the end of the first week in June. One does not find many young then but. by the end of the month. broods are common. Most hatch between mid-June and early July, and newly hatched young continue to appear throughout July.

I have not been able to deduce any fixed schedule for the daily brood-activities of the canvasback. During the heat of the day, they are found frequently in the rushes of island or border growths. but I have seen many broods spending the greater part of hot days in open water, far from shore. Periods of greatest activity come during the hours of twilight—morning and evening. Then all broods are feeding or traveling. They are active in moonlight and. on bright nights, they may be seen in open water. On dark nights, or during stormy weather. I have found broods on dry shores in Phragmites beds, on muskrat houses, or on coot nests. But it takes severe weather to bring them ashore. and I have seen broods in open bays on days too rough for canoe travel.

Newly hatched ducklings are able to dive as soon as their down is dry, but until they are about two weeks old they obtain most of their food on the surface. I have never seen a hen bringing food to her young. Nevertheless,



Canvasback hen feigns injury to draw attention from a newly hatched brood. Unlike some other species. she ceases this practice as the young grow older.

she guides them to the most favorable feeding localities; when she stops to feed, it is a signal for the ducklings to feed also. The agility of the canvasback duckling is incredible. Captives snap houseflies from mid-air when but a few days old. I have watched wild downies taking flying insects, and I suspect that much of their early food consists of the aerial and aquatic insect life so abundant in the summer marsh. After the ducklings are two or three weeks old, they dive for much of their food, feeding in a broad fan spread out around the mother.

No ducklings have been collected for food-habit studies, but I have observed that the young prefer to feed over beds of sago pondweed, or over thin beds of water milfoil. I suspect that the animal life, as well as the plant material, attracts them to such places. Dense beds are avoided, doubtless because of the difficulty of swimming through the tangles, which reach to the surface in July. Not only do ducklings and young grebes become hopelessly entangled in such beds, but I have also found flightless adults trapped.

The canvasback hen is not so faithful a mother as the pintail, the blue-winged teal, or other of the river ducks. A hen with a newly hatched family may remain as an intruder approaches closely, or may offer a bit of injury-feigning, but hens with older broods often abandon their ducklings, sometimes not returning for an hour or more. There is much individual variation, however, and several times I have seen protective canvasback hens feigning intensely.

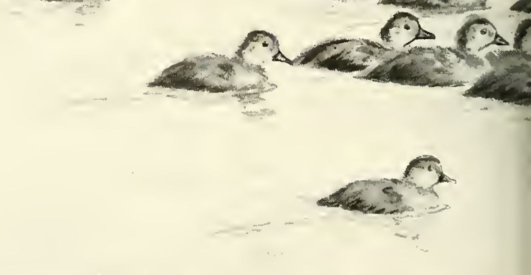
When harassed, following the departure of the mother, the ducklings skitter for open water, where they separate and dive, swimming to a considerable distance before bobbing up for air, then going under and away again. Birds two or three weeks old make three or four lengthy dives before showing signs of tiring. When less than a week old, however, they tire easily, soon becoming unab
force themselves under water.

After absences induced by dis
ance, the mother may return to
her brood dispersed, and fail t
trieve them all. Or she may find
downies from another scattered fa
have joined hers. Strange young
not always accepted, however. On
eral occasions I have seen canvas
as well as redhead mothers in th
of driving away ducklings of
own species, presumably interlo
Such behavior suggests that, alth
the hen cannot "count" her brood
can tell hers from strange duckl

In all species of ducks, one pa
less brood may on occasion
another in its entirety, and the pr
may repeat itself until finally a
aggregation results. An extreme
is that of a white-winged scoter
I saw with eighty-four young, all u
two weeks of age! Lesser scaups
commonly seen with broods of tw
or more, sometimes with two or
hens attending such combined f
lies. But canvasback and red
broods of this size are rare at D

Canvasbacks at Delta require
nine to eleven weeks to attain f
The first young are on the wing by
second week in August, and the
jority by the first week of Septen
A belated minority is still learnin
fly in late September or early Oct

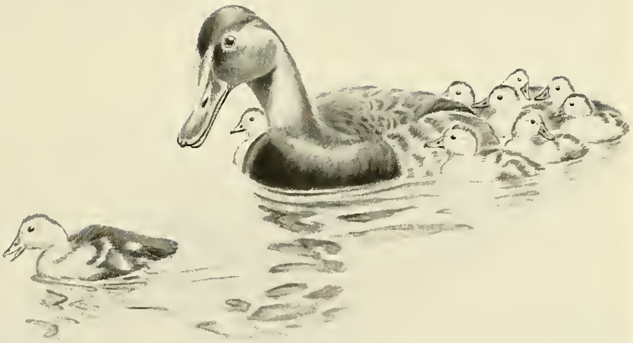
The canvasback brood does
spend the entirety of this pref
period with the mother. The hen a
dons her young before they are



Some adults accept young from broods that have been scattered by fright or for other reasons. Sometimes one br
without parents will join anothe

The same is true of all other ducks that breed at Delta. The which young canvasbacks and oung diving ducks are aban- depends largely upon the date hing. A hen may remain with ly hatched brood until it is ready to fly; but the late- l young often are abandoned nly two or three weeks old, or rlier. The first week in August, ter how immature the young , is very nearly the latest date h canvasback hens accompany roods. After this, parentless re the rule; hens with broods eption.

early abandonment may be in- l by the summer molt of the fore she moves south again, a e renewal of the wing feathers ke place. All of the old flight s are lost at the same time and, ew ones develop, the hen is s for a period of three or four Apparently the time of the wing balanced delicately with the eproductive cycle, so that it t occur until she has completed od duties. Should canvasback s remain with their ducklings ey were able to fly, some would able to complete the molt for autumn migration. The andonment of the brood, then, the hen to molt and renew well ahead of the freeze-up. e young canvasbacks are aban- y their mother, they gather in These are often composed of f different ages from several broods, the younger birds following an older duckling as they would the parent hen. In late July or August, it is not uncommon to see a brood of two- or three-week-old birds tagging along behind a four- or five-week-old. This "following" behavior is so strong that these ducklings will sometimes cling to a flightless adult drake of another species: parentless redheads sometimes travel with such bands of canvasbacks. These bands seem less inclined to wander than broods with hens, and I have seen what was apparently the same band in the same water day after day. Such birds are much less wary than those attended by a mother; sometimes they may be approached to within ten or fifteen feet before showing alarm.

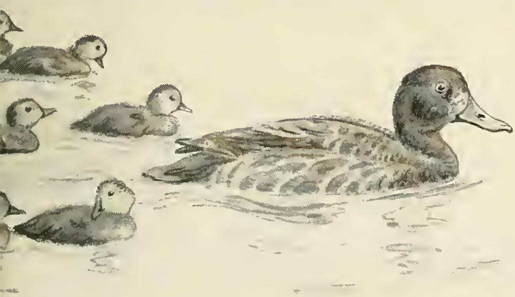


Downie from another brood is driven off by canvasback hen. While she does not "count" her ducklings, she seems to be able to distinguish a stranger.

As full development approaches, the young gather in large, loose aggregations in the open waters of the bigger bays. As soon as they are able to fly, there is much movement of young birds between marsh and lake.

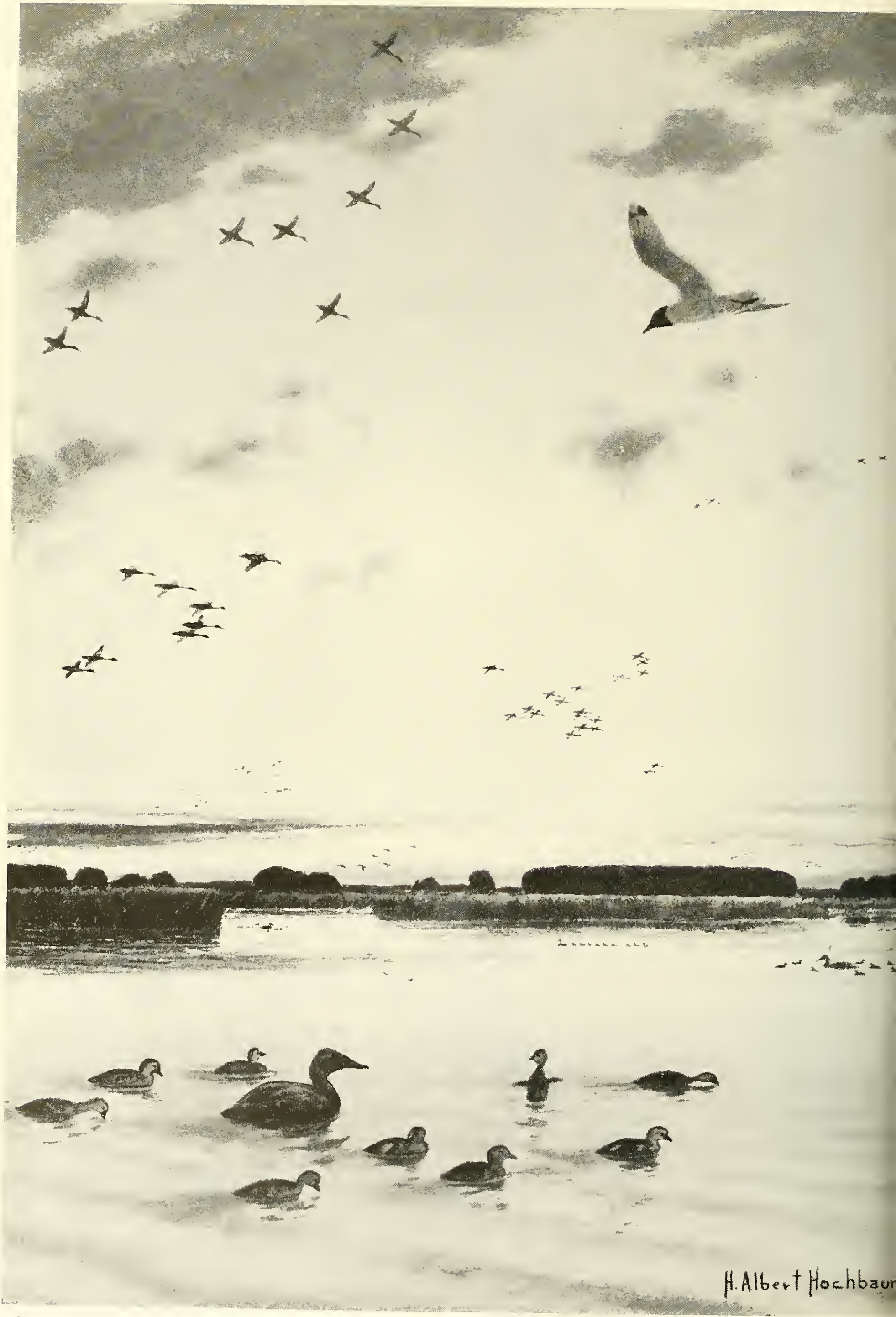
The downy canvasback can be mistaken for but one other duckling on the Delta Marsh—the redhead. Day-old birds of the two species are nearly indistinguishable at first glance. Both are predominantly yellow on the sides of the head, neck, breast, and underparts. In both species the crown and back of the neck, as well as the upper parts, are of a darker, olive shade. The only field difference between the two is in the color of the upper parts—the canvasback is a shade darker. One authority, marking this color difference, described the upper parts of the canvasback as varying from "sepia" to "buffy olive," and the upper parts of the readhead as being "light brownish olive" in tone.

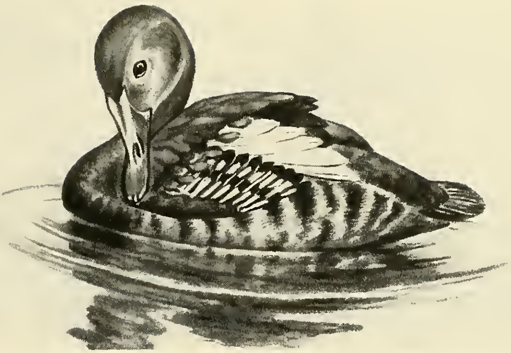
The plumage development of young canvasback is not rapid. The first juvenile feathers do not appear until the bird is about three weeks old. Then true feathers begin to replace the natal down. It is not until the contour plumage is completely developed that the



rety. Process may be repeated giant brood, *above*, is collected.

On occasion, two or more hens will act as attendants to such combined groups.


H. Albert Hochbau



Molting hen has abandoned her brood by early August, no matter how young they may be. Her wing plumage must be complete in time for autumn migration.

eathers of the wing are fully so young birds cannot fly until enile plumage is complete.

plumage development, as ob- in large numbers of young can- cs reared in the Delta Hatchery, n on pp. 60-61: field observa- ıdicate that the development of birds is closely matched by n the wild. In captives, there riation of about two weeks in iod required to reach the flying a similar variation has been d in the wild.

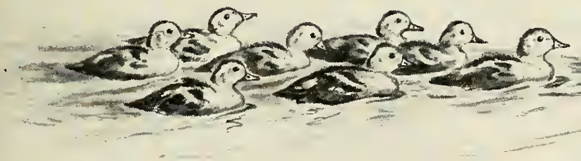
juvenile plumage is worn for hort period only, as the molt first breeding plumage begins he birds are twelve to sixteen ɔld. In the male, the eye color to change from olive-yellow to vermilion at ten or twelve By the time the birds are a or twenty weeks old, they are o their breeding plumage, but in full plumage until January ruary. The juvenile wing is l until the bird is about four- nths old, and is changed in the stnuptial molt.

plumage development of can- cs at Delta may not be the same hose reared in other latitudes. ssible that the greater amount ight in more northern breed- rshes may cause more rapid Each October—during the pas- northern birds through the region — canvasbacks encoun- hunters' bags are more ad- in the development of the g plumage than are any of the ocally reared. Many of these identified as birds from other brown stainings on the breast never present in local ducks), are fully two weeks ahead of the most advanced Delta juveniles.

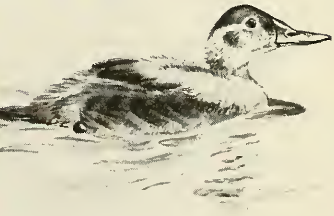
In the bays of Delta, diving ducks rear their young largely in open water. They do not shun the cover of emergent growths, but daily activities take place more in the open than at the marsh edges. River ducks, on the other hand, usually rear their families in the dense cover of the edges. To be sure, they move and feed in open water, particularly in twilight hours, but far less so than do the diving ducks. When one intrudes upon a brood of river ducks in open water, the young usually make haste for the nearest cover. Diving ducks, however, more often seek sanctuary in open water, where they escape by diving. Young redheads or canvasbacks hidden in the reeds have made themselves known to me by a frantic rush for open water as I passed by.

There is much variation in the behavior of brood females, particularly in their reaction to the intrusion of man. At Delta, feigning-behavior is most intense in the pintail and blue-winged teal. A mother pintail will give a show of feigned injury that would put any killdeer to shame. Redheads, like canvasbacks, will feign with a newly hatched brood, but the feigning seldom is well acted.

Local guides insist that a mother duck has a vocabulary of calls and signals by which she directs her young, particularly in moments of impending danger. Students of bird behavior have shown that birds do have, in their innate behavior pattern. a code of movements and utterances that, when given expression by one member of a group, effects a response in other members. When I approach a brood of teal in the open marsh, the hen's first reaction to my presence is evasion. She stops feeding and swims away



feed most actively morning and evening. At dawn, ung are guided by hen to best feeding localities.



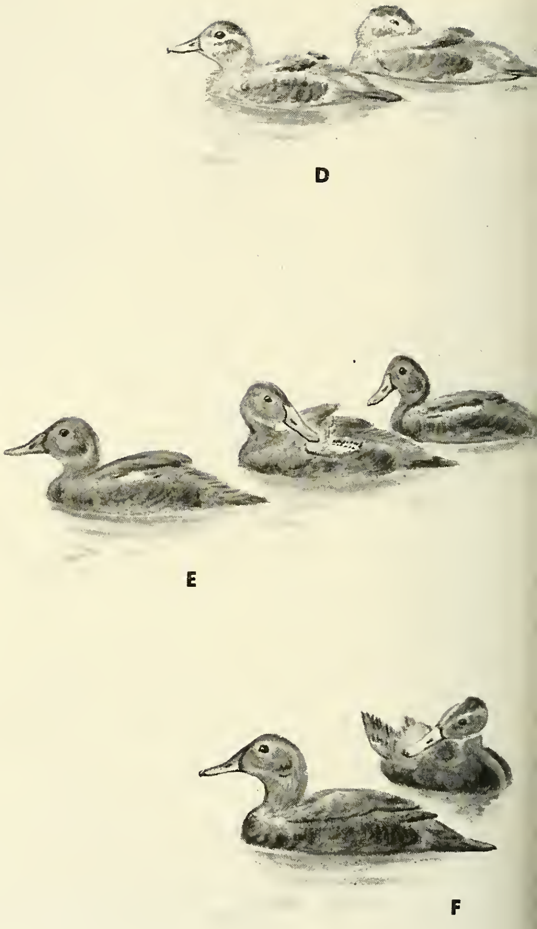
Ducklings abandoned during hen's wing molt form bands and follow older duckling, *above*, as they would a parent.

MR. HOCHBAUM, who illustrated his text especially for this magazine, is Director of the Delta Waterfowl Research Station in Manitoba. The article is excerpted from his book, *The Canvasback on a Prairie Marsh,* published by The Stackpole Company.

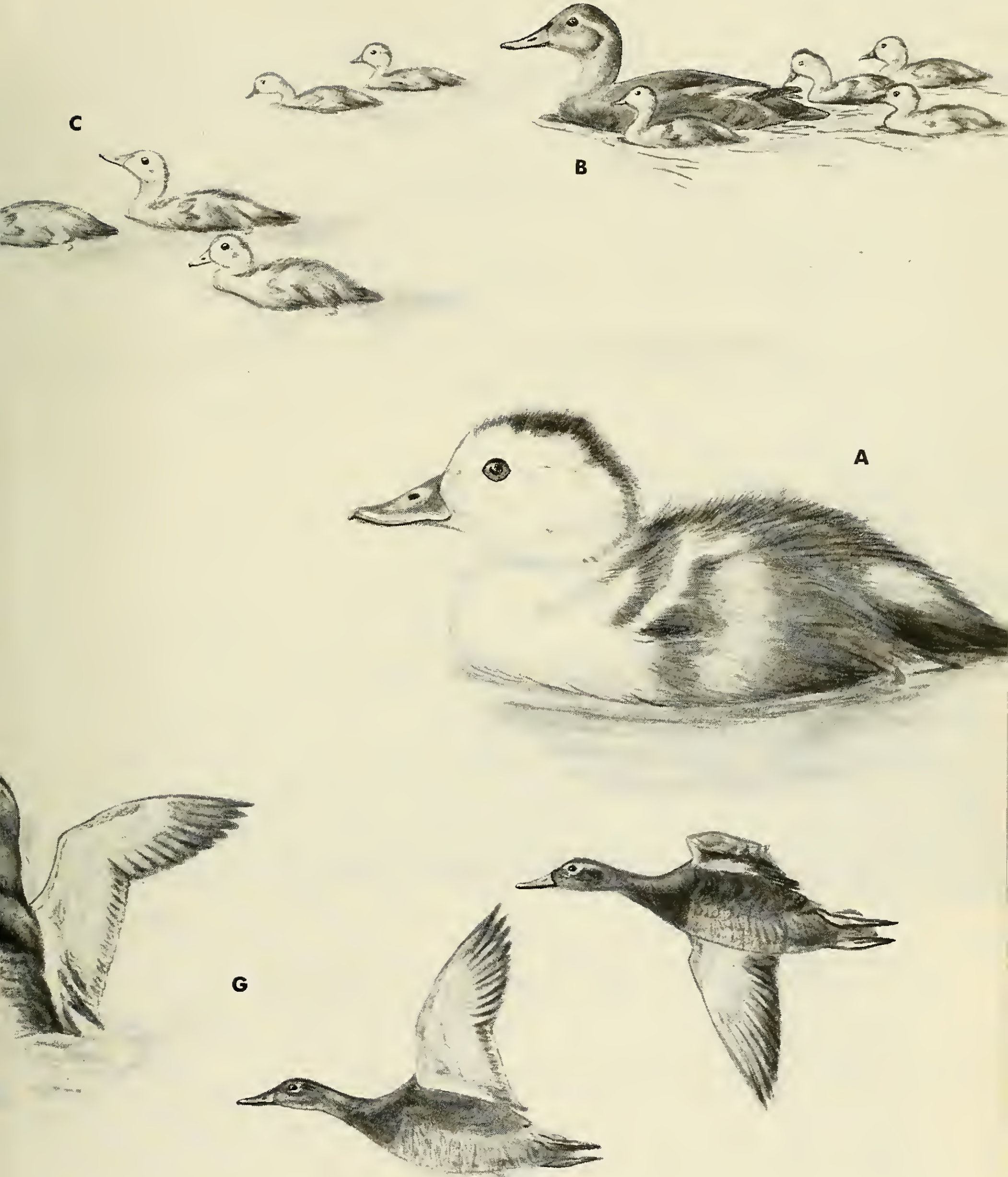
from me, the brood following her. As I continue to advance, she increases her speed until she is swimming as fast as the brood can follow. Then, as I continue to keep pace, there occurs a very rapid series of movements, and a change of behavior. Suddenly the hen utters a low, reedy, *whank, whank,* and flaps away from her ducklings in injury-feigning action. At the same moment, the young—which until now have followed their mother's every move—rush away from her in a pell-mell, water-churning scurry for the cover of the nearest reeds. The special note of the hen, followed by the feigning actions, releases the escape reaction in the young.

ANOTHER type of directive signal functions to hold the family together. A mother blue-winged teal, kept for a period in captivity, constantly uttered a soft, low, *pe-tunk, pe-tunk* note. As I watched the family travel through the dense grass of the flying pen, the mother often was three yards or more ahead of her young; yet they accompanied her unerringly through the grass, not following her trail, but "cutting corners" when she changed her course. Apparently her note was a constant signal of identification and position by which the ducklings traced her movements, even though she was out of sight. The young, in turn, kept up a constant soft "peeping" among themselves, which held them together as a brood. Once I scattered them in the grass until they seemed hopelessly lost from each other. After a few moments of silence, stray "peeps" came from every corner of the pen and, shortly, the ten ducklings were again behind their mother.

I have pointed out that parentless young canvasbacks are much less wary than ducklings attended by a mother. Undoubtedly, the role of the hen in directing ducklings through her own responses to danger is an important factor in brood success. I suspect that broods attended by the mother until they reach the flying stage are much more successful than broods abandoned before they attain flight.



PLUMAGE DEVELOPMENT of a canvasback begins with a newly hatched duckling's yellow down, **A** contrasting with olive of back and crown. The patches fad when duckling is about half as la as hen. Cheek patches appear at arou

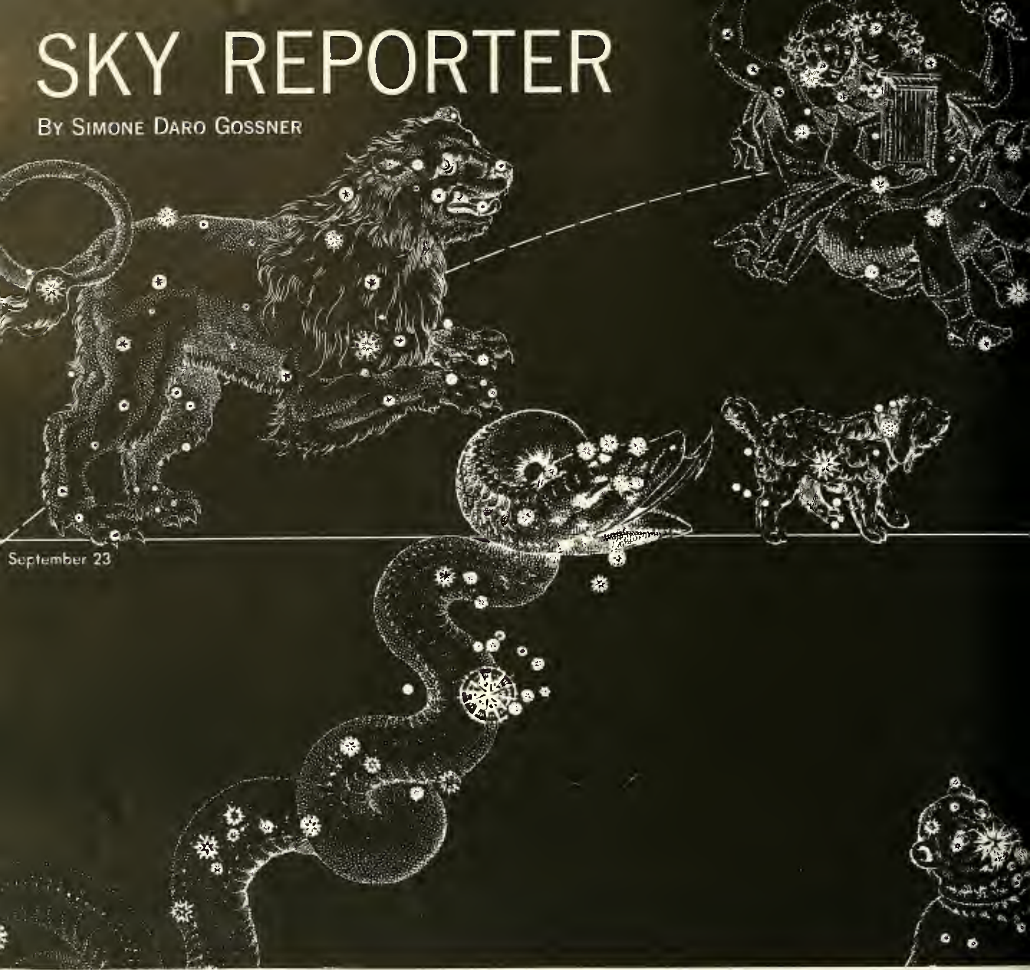


eeks **C** and tail is prominent. still persists, **D** although flank ıpular feathers become distinct.

When about three-quarters the adult's swim-size, bird is nearly feathered **E.** Now almost fully grown, **F** bird's feathers do not quite cover rump. At fifty-six days, feathering is complete. Now, **G** juvenile may begin flight.

SKY REPORTER

By Simone Daro Gossner



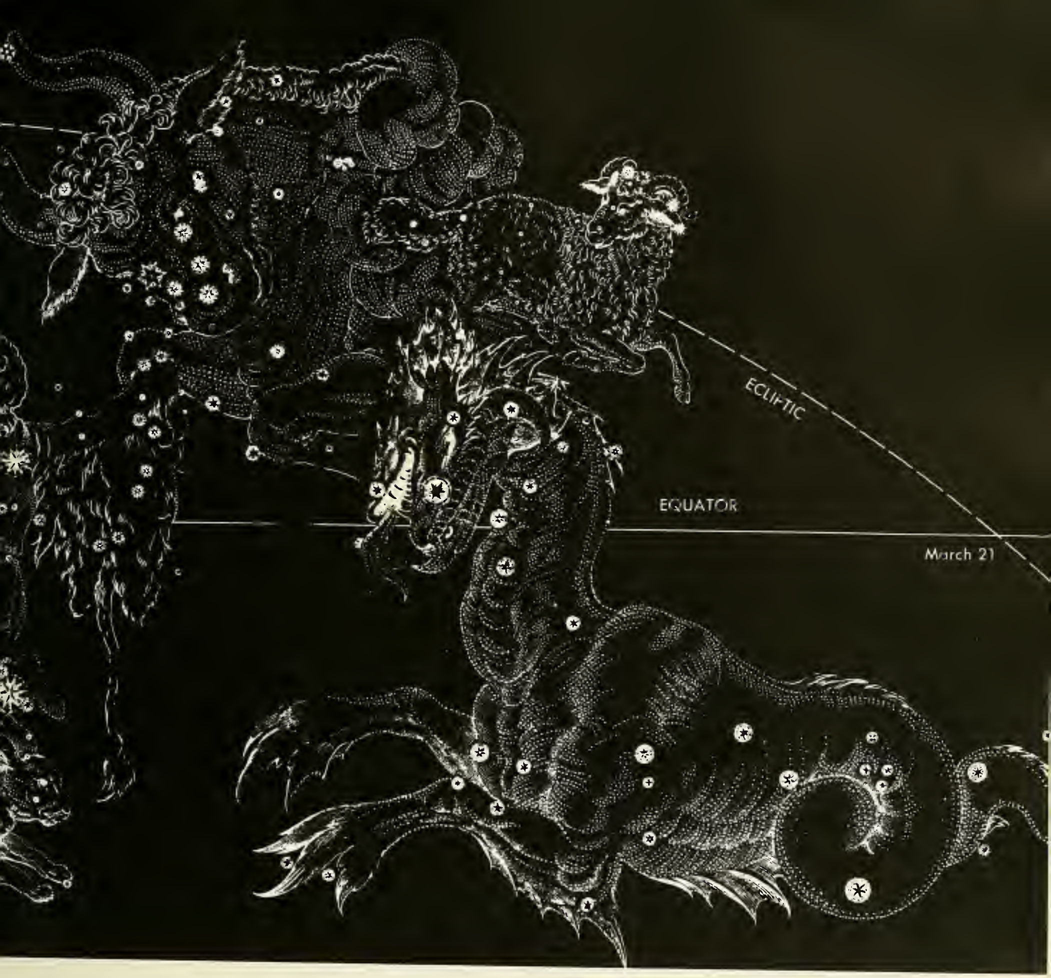
When summer arrives in our Northern Hemisphere, the earth is actually farther away from the sun than at any other time of the year. However, the difference between maximum and minimum distances from the sun produces only a six per cent difference in the radiation received, and this effect is lost amid the other factors that bring about the warm season.

The axis of rotation of the earth is inclined to the plane of its motion around the sun, while its orientation in space remains constant; therefore the North and South Poles are tipped alternately toward the sun as the year progresses. As a result, the sun's apparent yearly course in the sky does not follow the celestial equator, but the path called the ecliptic (curve in illustration, *above*), which takes it through the successive constellations of the zodiac. From the spring equinox, on March 21, to the autumnal one on September 23, the ecliptic lies north of the celestial equator. On June 21, the sun reaches the northernmost point of its path: that is, its northward progress is stayed as it begins once again to move south. This is the summer solstice, from the Latin *solstitium*, "sun standing still."

At the summer solstice, in temperate zones, the climbs higher in the sky than on any other day of year. Thus its rays fall more directly on the earth's face, imparting to it more heat proportionately. In addi to this, the summer solstice is also the longest day of year, and therefore enjoys the most prolonged perio insolation. Yet this is only the first day of summer, ceding the hottest days by several weeks.

The upper layers of the earth's crust absorb and s solar heat. As the intensity of the sun's rays begins to crease, the stored heat is released gradually into the atm phere. The atmosphere, however, acts as a sort of blan retarding heat dissipation into its upper levels. This ef added to the normal insolation, causes a temperature crease comparable to the conditions in a greenhouse. result, maximum temperatures occur generally in Aug after which the progressive decrease in solar heat beco once again the dominating factor.

Seasons are reversed in the Southern Hemisphere si the South Pole is tipped toward the sun from Septembe to March 21, and the summer solstice occurs on Decem



the Equator and in the tropical regions, seasonal ions are much less pronounced, because the length is nearly constant throughout the year, and because less variation in the altitude of the midday sun. poles, on the contrary, insolation is uninterrupted months. In fact, the total amount of heat received are mile in a single summer day exceeds by about five per cent the amount received at the Equator. lective power of winter snow accumulations, not dissipated until early summer, provides the main vhy polar summers are not the hottest on earth.

warmest days of summer are often called dog days ommon language. The expression refers to an ill- period, extending roughly from mid-July to early At that time of the year, Sirius (the "Great Dog the Romans—see illustration, *above*) rises in the sky, just before sunrise. This fact had been noted ncient Egyptians, to whom it heralded not only nt of sultry days, but also the annual rising of . So important was the heliacal rising of Sirius to the Egyptians, that they used its recurrence to measure the length of the natural year, in a manner similar to our astronomical use of the spring equinox.

The Greeks and the Romans inherited the Egyptian beliefs concerning the influence of Sirius on the weather. They even thought of a "scientific" explanation for it: it was assumed that, at midsummer, the proximity of Sirius and the sun caused them to mingle their rays and thus produce the added heat. There was no River Nile in Athens or in Rome; the summer season brought only parching skies and pestilence. It is not surprising then to find that Greeks and Romans saw Sirius as a symbol of evil that must be appeased. Homer and Hesiod allude to the nefarious influence of the star, and Ovid, among others, tells of dogs sacrificed to secure its good will.

Somehow, the notion of the Dog Star—and of the summer calamities for which it was held responsible in the ancient world—became confused in the minds of later generations. Thus, the belief that dog days may cause madness in dogs is a fine example of mythology gone awry, and a wholly modern addition to the lengthy list of classical superstitions.

THE SKY IN JUNE AND JULY

From the Almanac:

First Quarter: June 2, 11:02 A.M., EST
Full Moon: June 9, 8:02 A.M., EST
Last Quarter: June 15, 11:36 P.M., EST
New Moon: June 23, 10:27 P.M., EST
First Quarter: July 1, 10:49 P.M., EST
Full Moon: July 8, 2:37 P.M., EST
Last Quarter: July 15, 10:43 A.M., EST
New Moon: July 23, 1:31 P.M., EST
First Quarter: July 31, 7:39 A.M., EST

The solstice will be reached on June 21, at 4:43 A.M., EST, marking the beginning of summer in the Northern Hemisphere. The sun will attain its northernmost declination on that date (see pp. 62-63).

For the visual observer:

Mercury will be at its greatest eastern elongation on June 19, and will be most favorably located—about five degrees south of Pollux—on that date. It will remain in the evening sky throughout the month of June, setting ninety minutes after sunset on June 1, one and three-quarter hours after sunset on June 15, and one hour after sunset on July 1. Approaching the sun gradually during the first half of July, it will be in inferior conjunction on July 16 and will remain poorly placed for observation (in the morning sky) for the remainder of that month.

Venus will be too close to the sun for observation both in June and July. It will be in the morning sky until June 22. On that date it will be in superior conjunction with the sun and will enter the evening sky.

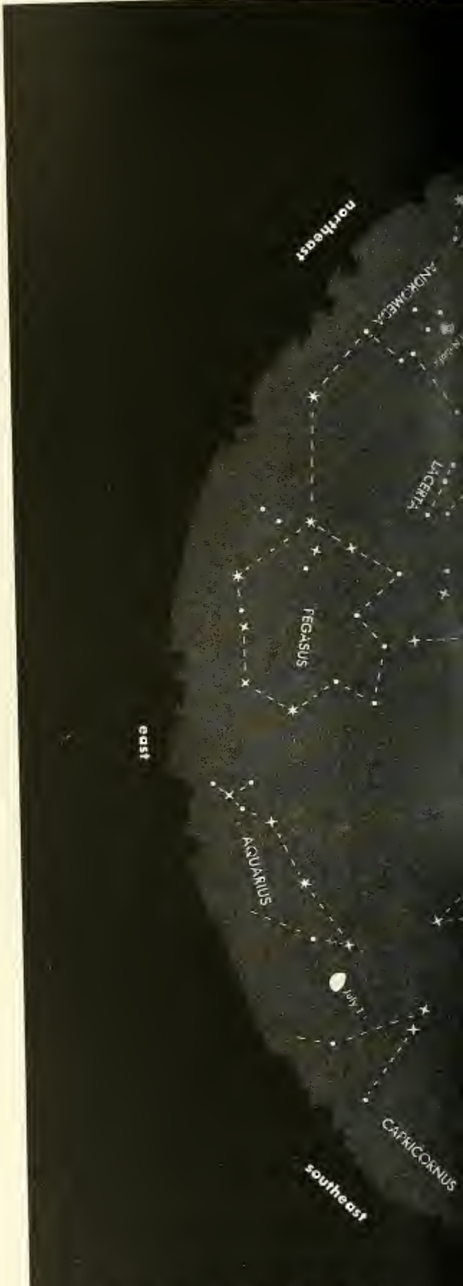
Mars (+ 1.0 magnitude) will rise in the east at about 2:00 A.M., local standard time on June 1, and will continue rising about two minutes earlier each day in June and July, making it thus approximately 1.00 A.M. on July 1 and midnight on July 31. At the end of July, its magnitude will have brightened somewhat to + 0.9, and it will be found south of the Pleiades, looming high in the eastern sky at the onset of dawn.

Jupiter will be located between Sagittarius and Ophiuchus about fifteen degrees east of Antares. It will rise one hour after sunset on June 1, and at sunset on June 15. After that date, and for the rest of June, it will be up in the southeastern sky after dark, passing low in the south near midnight and setting in the southwest shortly before dawn. In July, it will be favorably placed in the evening sky (see map) and will set about forty-five minutes before sunrise on July 1, two hours before sunrise on July 15, and three hours before sunrise on July 31.

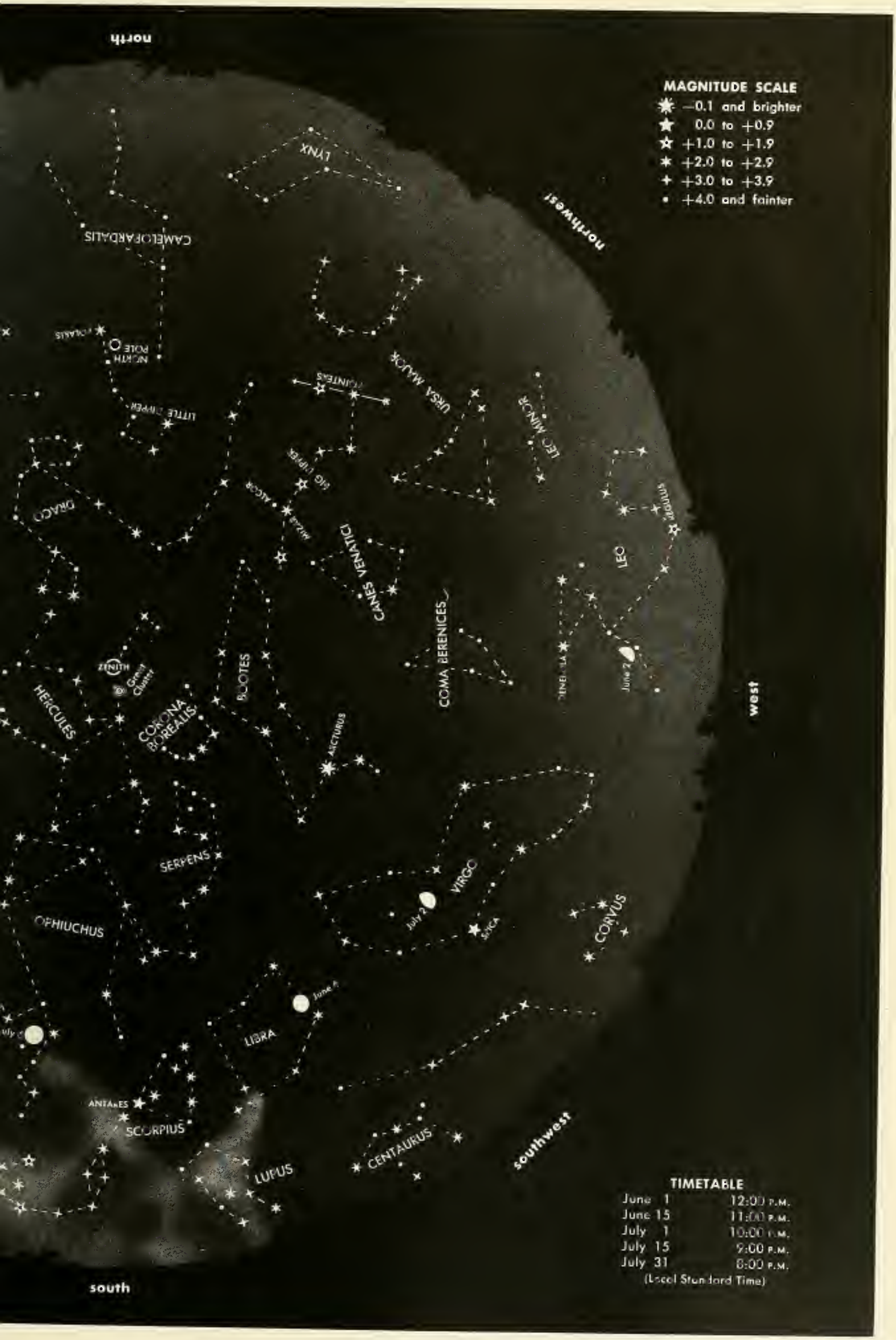
Saturn, in Sagittarius, also will be visible in the evening sky. It will rise about two hours after sunset on June 1, one hour after sunset on June 15, and in the evening twilight on July 1. Visible all night throughout the month of July, its brightness (+ 0.3 mag.) will be nearly two and a half magnitudes fainter than Jupiter's.

The Delta Aquarid meteor shower is expected on July 29, with a possible maximum rate of twenty per hour. A few Perseids may be seen in late July, although the Perseid shower does not reach its maximum until August.

The former Astronomy Editor for NATURE Magazine, MRS. GOSSNER, continues in that role for NATURAL HISTORY.



To use this map outdoors, hold it in such a way that the direction you wish to face is printed at the bottom. The constellations depicted below the point marked "zenith" are visible in that part of the sky at the time indicated.


north
LYNX
CAMELOPARDALIS
northwest
POLARIS
NORTH POLE
LITTLE DIPPER
POINTERS
URSA MAJOR
LEO MINOR
DRACO
BIG DIPPER
ALCOR
MIZAR
REGULUS
LEO
CANES VENATICI
COMA BERENICES
DENEBOLA
June 2
ZENITH
Great Cluster
HERCULES
CORONA BOREALIS
BOOTES
ARCTURUS
west
SERPENS
VIRGO
July 2
SPICA
CORVUS
OPHIUCHUS
June 2
LIBRA
July 2
ANTARES
SCORPIUS
LUPUS
CENTAURUS
southwest
south

MAGNITUDE SCALE

- −0.1 and brighter
- 0.0 to +0.9
- +1.0 to +1.9
- +2.0 to +2.9
- +3.0 to +3.9
- +4.0 and fainter

TIMETABLE

June 1	12:00 P.M.
June 15	11:00 P.M.
July 1	10:00 P.M.
July 15	9:00 P.M.
July 31	8:00 P.M.

(Local Standard Time)

WASHINGTON NEWSLETTER

By RICHARD W. WESTWOOD

FLINTLOCKS have been taken down from the wall, and already a few shots have been fired in a family feud in the National Capital. Involved are the United States Forest Service, in the Department of Agriculture, and the National Park Service, in the Department of the Interior. The bone of contention is a concept of land management called "multiple-use." This is no new development, actually—neither the feud nor the conceptual cause of conflict.

To understand the controversy it is necessary to recall the history of the two Federal agencies. The Forest Service was created in 1906 to administer acreage that earlier had been set aside from public domain and called the "forest reserve." These lands were redesignated as "national forests" in 1907. The primary concern was to keep these areas—now covering 180,000,000 acres —as sources of timber. Gradually this restricted view evolved into a broader solicitude for other assets of the national forests, including their value for watershed protection, their partial use as grazing lands and as sources of minerals, and their function as sites for recreation, including hunting and fishing. This extended program became known as multiple-use.

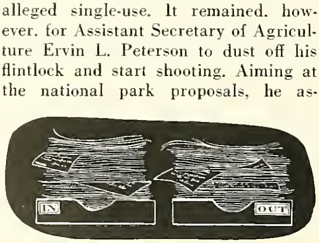
The National Park Service was established in 1916 to administer existing and future national parks and national monuments. Its responsibility was to promote and regulate public use of these areas, and especially to "... conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Today all the varied areas under National Park Service jurisdiction, from the twenty-nine national parks to the three national parkways, represent an aggregate of 24,400,000 acres.

Hunting is prohibited in the national parks, as is commercial timber-harvesting. Watershed protection is, of course, inherent in these areas, and recreation is an important use, although protection was and is the primary objective. To the fundamentalists among the multiple-use clan, parks constitute but a single-use, and thus, to them, a waste of resources.

A truce, now and then an uneasy one, would no doubt have continued, were it not for two factors. One of these is the strong drive for creation of a Wilderness System, now embodied in legislation known as the Wilderness Bill, S.1123. Under this program, certain outstanding primitive areas in the national forests, national parks, and fish and wildlife refuges would be given a protected wilderness classification by national law and would be removed from departmental regulations, so easily changeable at the stroke of a pen.

The other factor that has stirred up the multiple- vs. single-use feud has been recent demands for the creation of a number of new national park areas, including Northern Cascades National Park in the State of Washington, and Great Basin National Park in Nevada. Considerable acreage is involved, and most of it would be taken from national forest holdings.

Extensive hearings on the Wilderness Bill and the presentation of the park proposals in specific terms have resulted in much debate over multiple-use and alleged single-use. It remained, however, for Assistant Secretary of Agriculture Ervin L. Peterson to dust off his flintlock and start shooting. Aiming at the national park proposals, he asserted: "I am firmly convinced that action to weaken or dismember the tional forest system would be inim and contrary to the public interest.'



Training his sights on the wilder idea. Mr. Peterson declared: "True servation means management of forests, area by area, to achieve maximum of usable values from e location, and without impairing ability of the land area, the resou to keep on producing these va indefinitely."

From his side of the fence, Secre of the Interior Fred A. Seaton retur the Peterson fusillade. Taking ad tage of a Park Service conference Williamsburg, Virginia, Mr. Se wrote a special letter to Conrad Wirth, Director of the National I Service. The Secretary paid tribut those who had brought about the tional park system, and pointed out today the frontier is gone and we ar the midst of a population "explosi Competition for land is stiff and mands are intensifying. Mr. Seaton clared that: "There is every reaso believe that the next five or ten y constitute critical years if we are to what we need to our heritage of sce historic, and cultural treasures for use and enjoyment of the greater, largely urbanized population of future.

"Because of the situation wl America confronts in this respect," Secretary continued. "I ask you your colleagues in the National F Service to give high priority to a gram of studying and identifying a which should be preserved for the joyment and inspiration of all of people of America. These should clude seashores, scenic mountain ar prairie grasslands, places of nati importance in our history, and other tionally significant types of areas. important thing is that those place

intrinsic value for public refresh-
. enjoyment, and inspiration be
:ly identified, and steps taken to
ct and preserve them for this over-
g purpose before they are irre-
ibly lost to other uses. Action on
problem I believe to be of tran-
ent importance."

us the issue is joined. The feuding
; to derive from the very terms
ple-use and single-use — black or
, with no gray in between. It
l be obvious that no public land
provides only a single use; that it
render attendant services. It is
than a question of semantics; it is
a matter of philosophy of land
gement. Call it primary use, great-
, basic use, or something else, the
can only be served by a farseeing
f the proper status of our remain-
blic land assets.

Our Traveling Public

of that Americans are not content
sit still is found in the 1959 figures
vel to national parks and national
. The National Park Service re-
62,812,000 visitors to the twenty-
ational parks and 154 other areas
stered by the Service. This was
ease of 4,315,000 above the 1958
load. The twenty-nine parks re-
22,392,000 visits, an increase
1,671,000, or 3.3 per cent above
Of the national parks, Great
Mountains in North Carolina and
see reported 3,162,318 visitors.
Mountain, Grand Teton, and Yel-
e, among the more isolated park
were all in the 1,500,000-visitors
y.

e, of course, these figures repre-
me duplication, with Americans
more than one park on vacation
ey leave no doubt of the basic
of the National Park Service's
n 66," which seeks to be ready
estimated 80,000,000 visitors by
inning of 1966.

eational use of national forests
o an all-time high in 1959, with
00 visits to these areas. This
increase of nineteen per cent
58. The U. S. Forest Service re-
at the most popular purpose of
on visits was general aesthetic
nt of the forest. Following in
ity were picnicking, fishing,
and camping—in that order. So
as the 1959 visitation that the
found existing facilities in camp
ic sites inadequate to meet the
Although the Service's "Opera-
tdoors" has been striving to
rapidly rising visitor pressure,
and picnickers of necessity
eas where there were no provi-
protection of public health or
forest fires (which also in-
n 1959).

Migratory Waterfowl

If ever there was a vicious circle, it is that in which our migratory waterfowl, and those administering this wildlife resource, is involved. Counts of birds made prior to formulating the 1959-60 duck-hunting season regulations showed a marked reduction in the number of birds—a dangerous diminution in the numbers of canvasback, redhead, and ruddy ducks. Contributing to this situation were drought in some areas and continued drainage of those wetlands that provide breeding, resting, and wintering areas. Bag limits and open seasons were reduced in the hope that it would be possible to continue to shoot ducks and still have some in the future. Then came winter surveys, which revealed that migratory waterfowl had decreased eighteen per cent on the Pacific Flyway, and an alarming forty-two per cent along the Central Flyway. There was no illusion as to the bad conditions along the Atlantic Flyway.

This situation, with small bags, short seasons, and fewer ducks, caused many duck hunters to stay away from the blinds. So, they did not purchase the so-called "Duck Stamp," sales of which fell off about twenty-five per cent. Thus, some of the revenue from this stamp, which last year was increased in price by Congress from two to three dollars, and is used to acquire wetlands so vital to the birds, was cut at the worst possible time. Conservationists and the Department of the Interior launched a post-hunting campaign to spur sales of the stamp. Purchasers of the stamp would receive an accompanying certificate, signed by Secretary of the Interior Seaton, stating that: "The holder of this document did purchase the attached Migratory Waterfowl Hunting Stamp as a contribution to the essential management and protection of these birds, which constitute so vital a part of the American Wildlife Heritage."

There are those among conservationists who feel that it is dangerous to predicate a program of wildlife management on a fluctuating source of revenue, such as the duck stamp proved to be this past season. There are many more who deplore the practice of draining wetlands to create agricultural land we now do not need, and then turning around and acquiring lands to be flooded for migratory waterfowl. There is no doubt, however, that our duck and geese are in a fix as precarious as that of the early thirties, and they may be facing an even more dangerous future.

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Water Pollution

POLITICAL ammunition in an election year appears to reside in President Eisenhower's veto of the bill to amend the Federal Water Pollution Control Act. This was followed by the action of the House of Representatives, which voted to override the veto by a vote of 249 to 157—22 votes short of the necessary two-thirds. The measure was passed by the House in 1959 by a vote of 255 to 143, and by the Senate, 61 to 27.

Although it is now academic, the measure would have increased grants—from 50 million annually for ten years to 90 million annually for the same period—to municipalities for construction of sewage treatment plants. The ceiling of $250.000 for individual projects would have been raised to $450.000. The measure was approved by the Water Pollution Control Advisory Board and widely supported by conservationists.

The President's veto was on the ground that the primary responsibility is state and local; that ". . . holding forth the promise of a large-scale program of long-term Federal support, it would tempt municipalities to delay essential water pollution abatement efforts while they waited for Federal funds." He urged a national conference on water pollution [which would be another in a long series] and aid to local governments through research and technical assistance [which has been rendered for some time].

Military Conservation

ALTHOUGH the Army, Air Force, and Navy have been carrying on some conservation activities on lands under their jurisdiction, the Navy is the first to establish a Natural Resources Management Branch. Commander C. R. Zirzow heads the new branch, which has been placed in the Bureau of Yards and Docks, and which will manage nat resources on Navy lands. He will be sisted by three civilian consultant the areas of forestry, erosion control, fish and wildlife.

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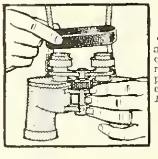

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Secretary of Agriculture Ezra Benson points out, however, that: have a lot of idle forest lands to get full production if we are to have the est products needed in the future. . . catch up with areas deforested in past and keep caught up, we will to increase the rate of planting. . . .

In the present statute, $450.000.00 allocated for the Conservation Res but only $375.000.000 were appr ated for the past fiscal year. Also, provision for the Conservation Res expires December 31, 1960, and u it is extended, as provided in se pending bills, no applications for cl fication of lands in this category ca accepted beyond that date. Applicat in the past have been about double number of contracts granted. This i entirely voluntary program.

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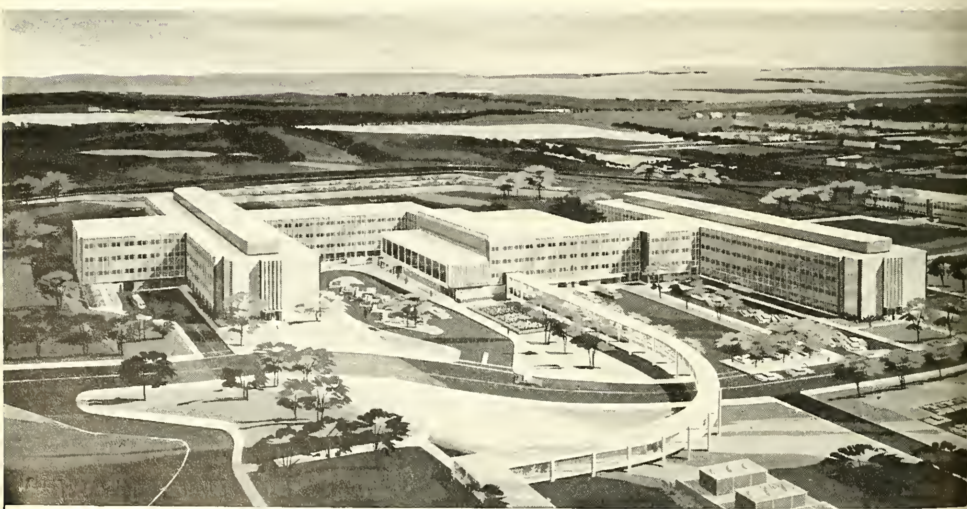

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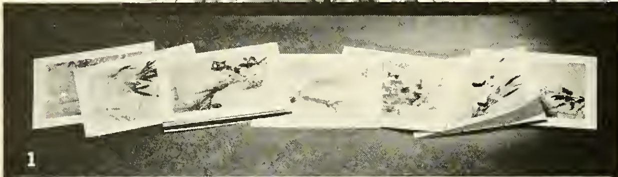
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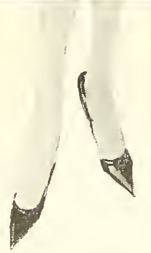

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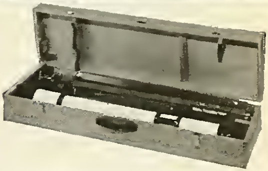

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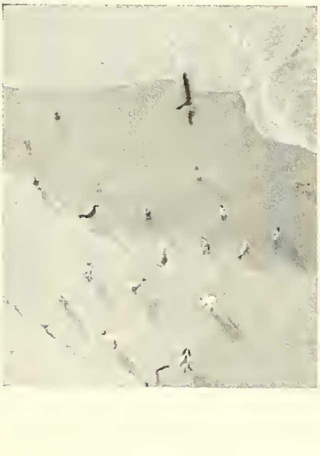

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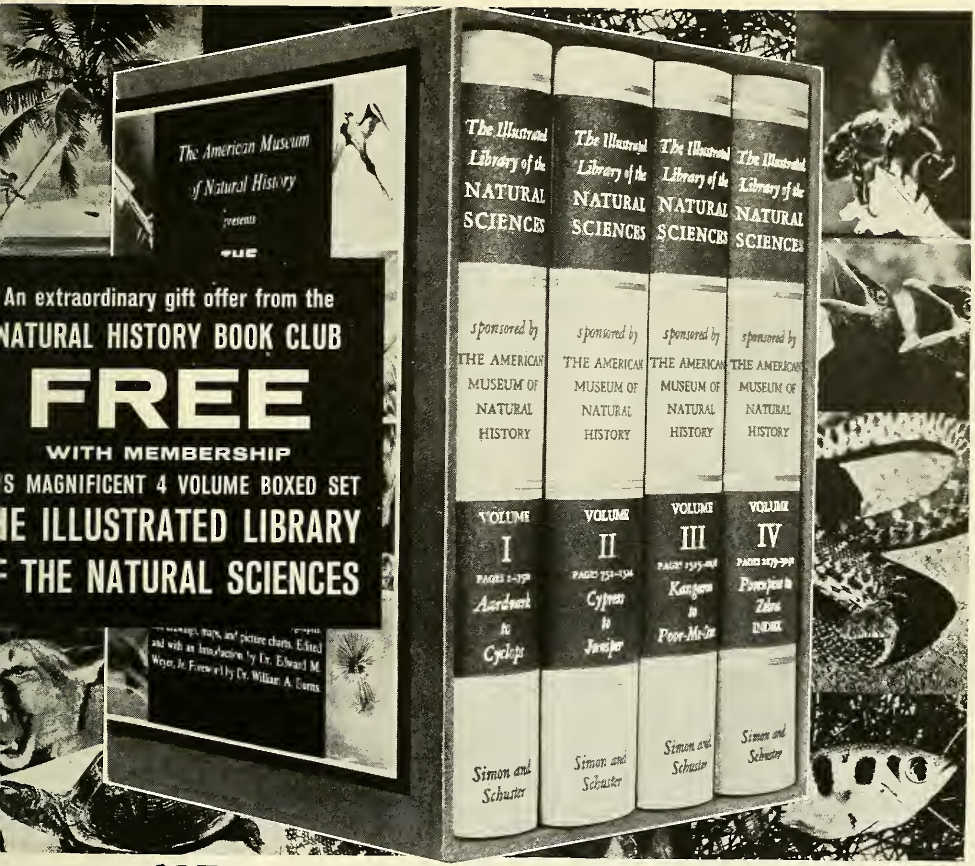
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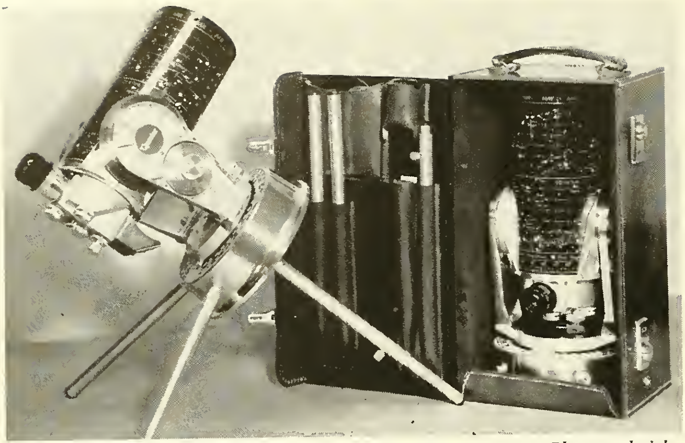

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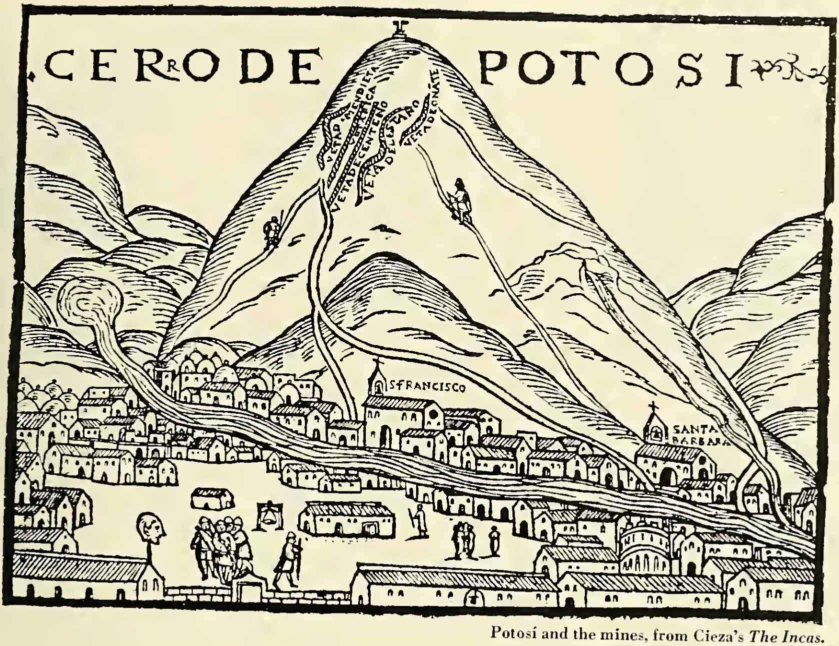

Potosí and the mines, from Cieza's *The Incas.*

Reviews in Brief

cas of Pedro de Cieza de León.
ted by Harriet de Onis, edited by
Wolfgang von Hagen. *University
homa Press, 1959, $5.95; lxxx+
, illus.*

knowledge of the extraordinary
pire of the Incas comes to us
from the writings of Spanish
priests, and officials who took
he conquest of Peru or lived and
there in the decades that fol-
This new translation once again
vailable in English the account
f the most careful and credible
s ever to write about the Incas.
41, six years after he landed in
World. Cieza began to write his
chronicles. It had already en-
mind to set down what he had
d, but modesty about his literary
at first deterred him. Later he
this hesitancy, having been
largely, he tells us, by the fact
I had taken notice wherever I
at nobody concerned himself
ing aught of what was happen-
(page 3).
in 1547, Cieza joined the forces
ián de Belalcázar, under orders
crown to proceed to Peru and
the rebellion led by Gonzalo
Pizarro. For four years he traveled over a considerable part of the country, observing, interrogating, and taking note of much of what he learned. He wrote his histories with a condor's quill, on pieces of foolscap, often with nothing better for a table than a drumhead. *La Crónica del Peru* was finished in 1550.

Cieza's *Crónica* comprised four parts. Part One, although consisting largely of geographical descriptions, also contained information about the local customs of the inhabitants of the valleys he visited, especially those customs that anteceded the Inca conquest. This part of the Chronicle, which was printed in Seville in1553, was the only one of the four to be published during Cieza's lifetime. Part Two, which remained in manuscript for more than three hundred years, deals with the Inca Empire, particularly with its achievements in government and religion. Of these first two sections of the Chronicle, the latter is by far the more useful to anyone seeking to learn about Inca culture.

The third and fourth parts deal, respectively, with the conquest of Peru and with the civil wars that arose among the Spaniards thereafter. They are of no particular interest ethnographically, and have been omitted from this edition.

Here, the two hundred-odd chapters comprising Part One and Part Two of the Chronicle have been rearranged, renumbered, and integrated into a single book. Not every chapter from the original Spanish text has been preserved; those dealing with Colombia, and a few considered by the editor to involve excessive duplication, have been deleted. The part and chapter numbers of the original text are given in parentheses after the new chapter numbers, making it possible to locate more or less easily any chapter whose number in the complete Spanish editions is known.

Cieza's outstanding characteristic as a chronicler is his passion for accuracy. Before any entry was included in his chronicles, he took considerable pains to assure himself that it was as nearly correct as his own interrogations and investigations could make it. In attempting to learn the facts about Inca civilization, Cieza was working at a disadvantage. The empire had been overthrown fifteen years before he arrived in Peru, and to reconstruct the fabric of Inca society he had to rely on informants rather than on direct observation. Someone less punctilious might have recorded the most dramatic version of an important incident without further qualifications, but

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Cieza never disguised the fact that what he portrayed often was only the best approximation to the truth. He tells us that his informants sometimes differed ". . . on many points, some saying one thing, and some another, and no human mind could put all this in order, but can only take from what they related that which they themselves consider most true . . ." (pp. 231-32).

Cieza was in general quite sympathetic toward the social system that the Spaniards encountered in Peru and overthrew. He repeatedly expresses admiration for the Inca achievement and, noting the amount of disorganization that prevailed in his time, occasionally upbraids his countrymen for recklessly destroying what the Incas had so carefully built. But one should not expect a complete or balanced account of Inca culture. Cieza himself was most interested in the administrative system by means which the empire was governed, and in Inca history and dynastic succession. In these matters, the information he provides us is deep and rich.

There is a wealth of material on the investiture of the Inca, his prescribed marriage to his own sister, his powers and prerogatives, his conquests at the head of his armies, and the like. Cieza was impressed with the honesty, competence, and justice with which the Inca ruled his subjects, and with the extreme awe and respect in which he was held by them. There is a brief but graphic description of the Inca system of taxation, which, while best known for exacting draft labor (the *corvée*), made use of taxation in kind as well. About other subjects, such as agriculture or architecture, the Chronicle teaches us comparatively less.

The present translation, by Harriet de Onis, is excellent. Cieza's meaning is rendered with clarity and fidelity, while at the same time the peculiar flavor of sixteenth-century Spanish is retained. Victor von Hagen has done a thorough job as editor. His introduction is, in all likelihood, the best biographical sketch of Cieza in existence, especially since it makes use of source material unavailable to previous biographers, and the footnotes provide background material that will make Cieza's account infinitely more meaningful to a modern audience.

ROBERT L. CARNEIRO,
THE AMERICAN MUSEUM

BENT'S LIFE HISTORIES OF NORTH AMERICAN BIRDS. 2 vols. Vol. 1, Water Birds. Vol. 2, Land Birds. Edited by Henry Hill Collins, Jr. *Harper, $5.95 each; 356 pp., 374 pp., illus.*

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exaggeration when he calls them "
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erto in America or the world." Li
they *are*, and one of their chief c
is that of following Mr. Bent,
the company of well-known Am
naturalists of the last generation o
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ing twenty volumes to two, has succ
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words of other naturalists as i
Bent's own unruffled prose.

Surprisingly enough, Bent start
an "oölogist," but unlike some a
of that vice, he largely outgrew it, t
he was never caught without an eg
and blowpipe in his pocket. Whe
paring each volume, he would w
The American Museum for me
ments of eggs not in his collectio
the reviewer recalls the trepidatio
which he approached the task of
uring the eggs of rare hummingbi
Mr. Bent. All such data Mr. Colli
happily deleted. The photographs,
formed a conspicuous feature c
originals, have also disappeared w
trace or mention.

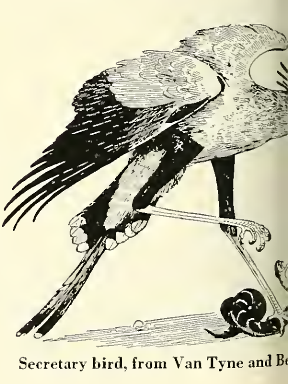
Anyone who wishes to enric
knowledge of American birds by l
ing through the writings of well-k
naturalists will appreciate these vol

DEAN AMADON,
THE AMERICAN MU

FUNDAMENTALS OF ORNITHOLOG
Josselyn Van Tyne and Andrew J
ger. *John Wiley, $11.75; 624 pp.,*

ALONG with the great increase in
bers of bird watchers, there i
increase in the ranks of serious stu
who wish to study ornithology in
tutions of higher learning. This v
is the best text currently availab
ornithology at the graduate level.

Some years ago, the late Dr. Jos
Van Tyne began a book on the bi
the world, which he eventually de



Secretary bird, from Van Tyne and B

ed hawk eagle, also from Van Tyne.

and into this textbook. After Van
s untimely death, Dr. Berger com-
it with skill and devotion. About
ird of the work is given over to a
of the birds of the world, with a
devoted to each family. Unfortu-
, some families have hundreds of
s, others only one; yet they all get
me space, and such unequal com-
on has its handicaps. The refer-
to be sure, permit one to go
r, and George W. Sutton's fine
ations add to the value of this
y section.

remainder of the book covers most
s of the science, beginning with
ssil history. The chapters are of
y uneven quality, but the average
. Regrettably, some of the recent,
g work on such subjects as orien-
and homing is not discussed.

book is written in straightforward
ge, and the layman, student, and
sional all will find it rewarding.

Dean Amadon,
The American Museum

de to the Planets, revised edi-
y Patrick Moore. *W. W. Norton,*
254 pp., illus.

English astronomer Patrick Moore
among the best of the scientist-
who have found a language in
professionals and laymen might
se. This revision of *A Guide to*
nets—updating the 1954 edition
such recent events as the 1956
ion of Mars are placed in per-
e—is no exception to his usual
e. In addition to chapters devoted
of the nine planets, the moon,
minor planets, the book has more
discussions of the origin and
s of the planets, life on the
, and space travel. Appendixes
e practical ways for the amateur
rve planets and record data, and
re suggestions for further reading.
y in this area is progressing very
, so fast that it is virtually im-
e for any author to include all the
ndings. Nevertheless, Mr. Moore's
n could have been improved by summaries of the work of Ross and Moore on water vapor in the atmosphere of Venus, of radio telescopic techniques for ascertaining the temperatures of planets, or of the procedures followed by Walker and Hardie in determining the rotation period of Pluto.

These failings notwithstanding, Patrick Moore's revised edition of *A Guide to the Planets* remains a fascinating, well-written Baedecker, and it will lead the interested layman to periodicals that will keep him alerted to the almost daily progress that is being made in this field.

Franklyn M. Branley,
The American Museum
—Hayden Planetarium

The Physiology of Forest Trees, a symposium held at the Harvard Forest, April, 1957; ed. by Kenneth V. Thimann. *Ronald, $12.00; 678 pp.*

Thirty-five papers on various aspects of tree physiology, from reproduction to root growth and water movement, are collected in this weighty tome. All are highly specialized, review-type articles of interest chiefly to trained botanists and designed primarily to grace the reference shelves in college libraries and research laboratories. However, other readers will find information of general interest in a few articles, particularly those concerning "The physiology of maple sap flow," "Dew absorption by conifers," and—despite the title—"Photoperiodic control of growth and dormancy in woody plants."

Those who have never attended a scientific conference may find the transcriptions of the discussions of the various papers by the scientists in attendance at the symposium to be of great interest. However, in most cases the discussions were allowed to meander far from the point and are in the superfluous conversational form characteristic of extemporaneous verbal exchanges. Stricter editing of these sections could have reduced the size of the book and, perhaps, its cost without noticeable damage to its content.

Jack McCormick,
The American Museum

Out of Noah's Ark, by Herbert Wendt. *Houghton Mifflin, $6.50; 464 pp., illus.*

Aurochs, tahrs, budengs, langurs, tapirs, dodoes, muhalus, chegos, and abominable snowmen are only a few of the creatures to which Herbert Wendt devotes himself in what purports to be a summary of zoological exploration. Actually, the material he has assembled has to do largely with the legendary, or at best the possible. It is fortunate that Wendt's style is pleasant and well managed; otherwise, his book might have been merely a turgid catalogue. Still, the mind boggles at times, as the reader finds

(continued on page 58)

TEENAGER DESIGNS A NEW COMPUTER!

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An Unspoiled Bit o

Atlantic Coast

New Jersey's Island Beach preserves a pre-Colonial landsca

By William E. Martin

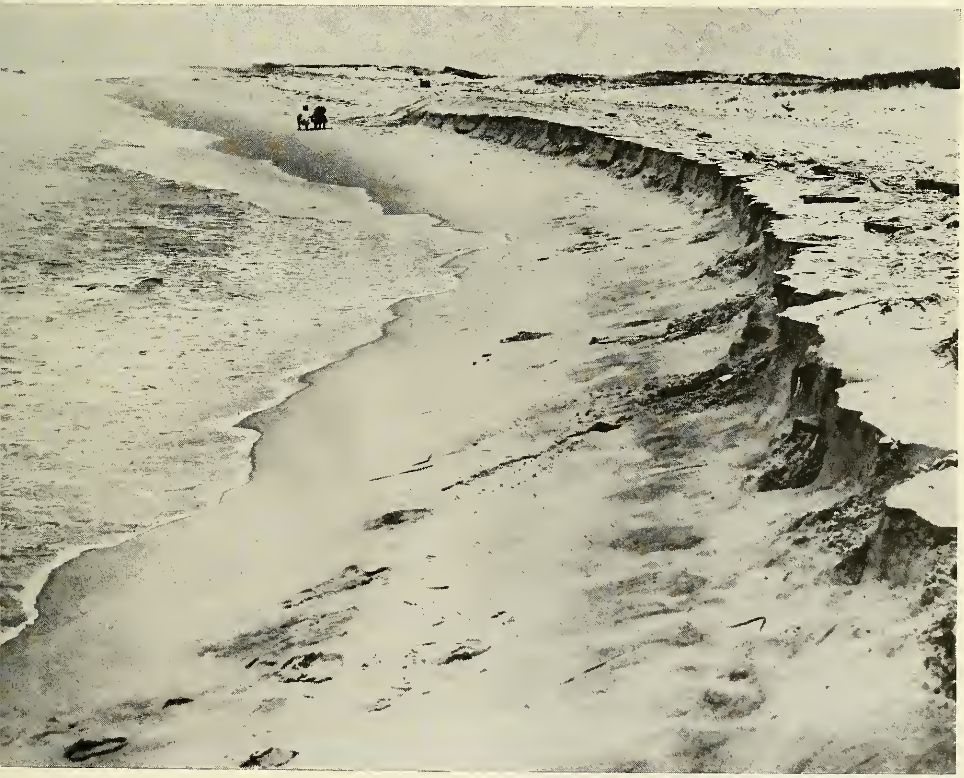
Island Beach State Park occupies the last undisturbed stretch of barrier beach in New Jersey, and probably the largest natural area of its kind on the North Atlantic coast. Consisting of a narrow finger of sand reaching from Seaside Heights to historic Barnegat Inlet, Island Beach is separated from the mainland by the quiet waters of Barnegat Bay and pounded on its eastern flank by the Atlantic Ocean. Its ten miles of ocean shore and more than 2,300 acres of dunes, thickets, woodlands, and marshes comprise a unique remnant of the primitive Atlantic coast, which looks today very much as it did to the early settlers.

A peculiar combination of historical circumstances is responsible, at least in part, for the fortunate preservation of this remarkable area. Barnegat Inlet, then unnamed, and the "beach" to the north are mentioned briefly in the log of Hudson's 1609 voyage, and local folklore contains the inevitable dead men, pirate's treasure, and the like. For a short period of recorded history—from 1750 to
1812—Island Beach was truly an island, its northern
marked by Cranberry Inlet. During the Revolutio
War, various enterprising, but poorly armed, Ame
privateers made use of the inlet to escape from the Br
whose larger ships could not navigate the shallow wa
For the bustling port of Toms River, on the New Je
mainland, it was a gateway to trade. That gateway
closed by a tropical storm, never to be opened again.

As settlements on the Jersey mainland grew into m
politan areas over the years, resorts spread ra
over most of the barrier beaches. In this early rash of
estate development, Island Beach was spared becaus
property owners preferred to keep their holdings a
vestments in a possibly even more prosperous future.

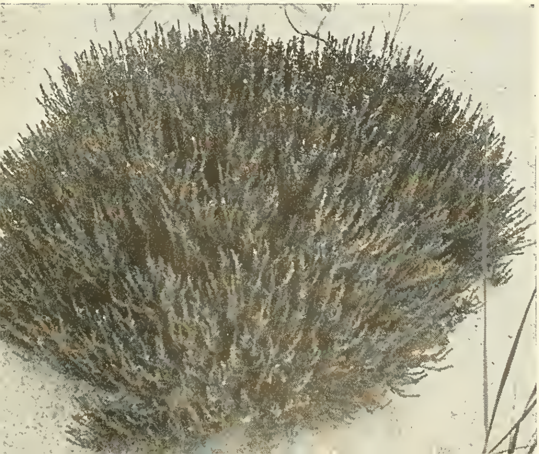
Toward the end of the nineteenth century, three C
Guard stations were built on the dunes, and some of
men stationed at these outposts obtained permissio

AGE POND at extreme southern tip of Island Beach mmer nursery area for terns. Masses of flightless young sit on the sand, leaning into the wind, and wait for their parents, who have caught large minnows, to find them.



SHORE, usually a smooth, sandy incline, is often ut by a heavy northeast blow. Surf fishermen can depend on a good catch when the undertow uncovers a food supply that lures fish into the shallow waters near shore.

BAY SHORE BANK is held against onslaught of waves by the tangled roots of plants and the windrows of cast-up eelgrass.



BEACH HEATHER, *left,* which helps to control wind ero turns brown in drought, becomes green again after a

build cottages nearby. With the precedent establis other cottages and driftwood shacks sprang up amon dunes, and houseboats appeared along the bay shore. over half a century, the forgotten beach south of Se Heights was a sort of squatter's paradise, populated marily by weekend surf fishermen. Then, in 1953, afte attempt to establish an exclusive resort, New Jersey chased the property for use as a state park.

Before the park was opened to the public in 1959, northern third of the ten-mile beach was set aside botanical preserve. The middle section was designate recreational development, while the southern portion reserved for a wildlife sanctuary (with limited recreati facilities) and a marine fisheries research laboratory the present time, Island Beach provides an unexc

nity to observe, to study, and to appreciate the strand of the North Atlantic in a virtually pristine particular, it is one of the few significant rem- f maritime vegetation in the region.

AL zones, or belts, of vegetation lie parallel to the re line and support a variety of plants and animals m a remarkable diversity of biotic communities. lk west from the ocean shore to the bay, one passes habitats as different as those that might be ered between the bottom and the top of a moun- ge. In part, these habitats are formed as a result n relation to, topographical facets of the region, an also be divided into a zoned mosaic.
lora of Island Beach includes at least 278 species

with other plants, the Virginia creeper, *right*, rm impenetrable thickets that shelter animal life.

Dusty miller *(Artemisia Stelleriana)*, an Asian wormwood first introduced as garden plant, now grows wild on dunes.

Dune grass, here growing sparsely, establishes footholds in the sands, stabilizing them against the wind and waves.

of higher plants representing sixty-six different families. Almost a third of these are weeds, and are found only along the main highway and around building sites. Some are introduced species, but only two are well established. Over half of the native plants are relatively rare. The bulk of the vegetation is composed of about seventy-five abundant species, which combine in various ways to produce many strikingly different kinds of vegetation cover.

The eastern edge of the area is a narrow strip of ocean shore, inhospitable to most plant life. The shifting provide no anchorage for rooted perennials, while th and brightness of the sun—together with the salt-lade breezes—prevent the growth of all but a few hardy als, such as the sea rocket *Cakile edentula*. While the is thus lacking in vegetation—the primary source o mal food—it supports an abundance of creatures de ent, directly or indirectly, upon the sea. One of these mole crab, *Hippa talpoida*, also known by the local

TING WAVES expose crustaceans y sandpipers, knots, dowitchers er shore birds, *above*, who race ahead of foaming water's edge.

s shellfish washed ashore by st storms sometimes litter the n windrows, *right*. Gulls feast s until wind-shift cleans sand.

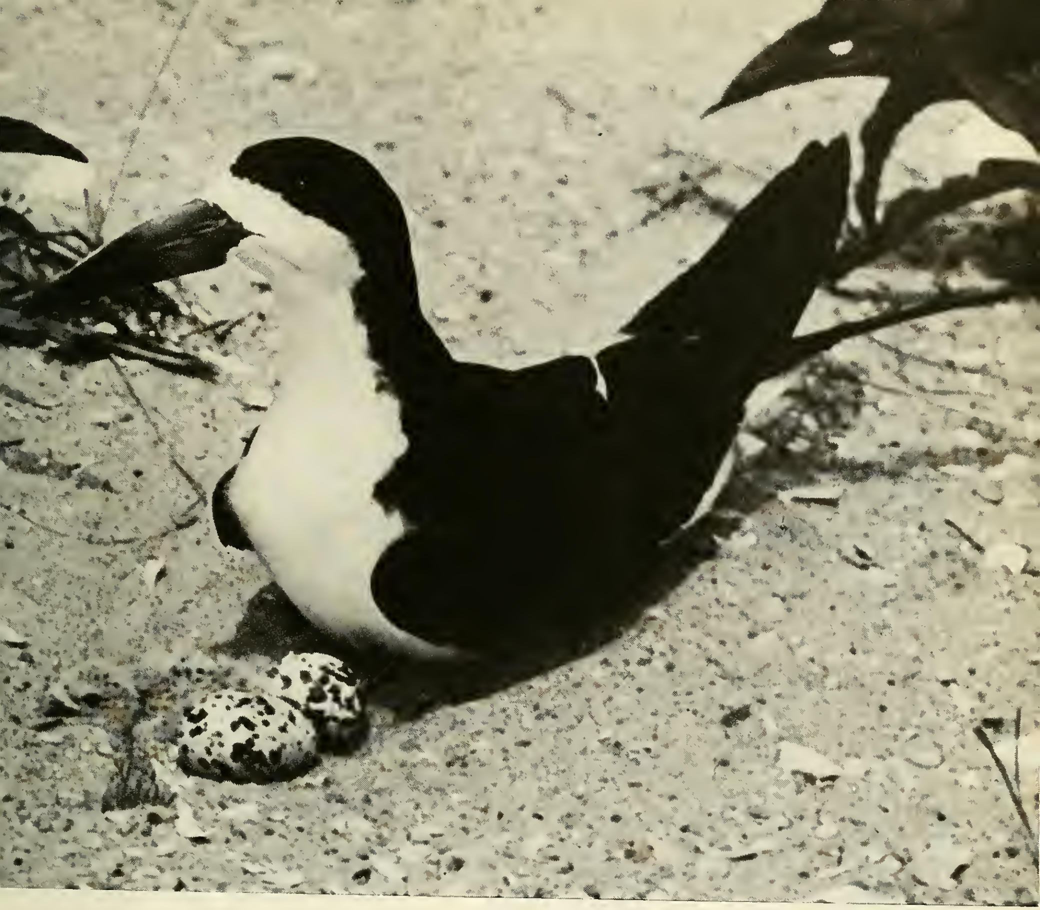
Least terns nest in secluded areas, to which they bring bits of broken shells on which they lay their fragile eggs.

Raccoons seem unlikely inhabitants of the barren dunes, but there is sufficient food to maintain their population.

of sand bug or sand crab. This small crustacean sits
etly, half-buried in the sand, and lets the water wa
and fro overhead. When threatened by danger, it bur
backward and virtually disappears—only its V-shape
tennae show. If the mole crab is stranded by low ti
digs down three to six inches in the wet sand, and
until the water has again invaded its beach.

The ghost crab, *Ocypode quadrata*, whose color
speed make it virtually invisible on the white san
another familiar member of the shore community. T
and many other small creatures are prey for cru
sanderlings, plovers, and other shore birds. The sa
lings seem to be playing a game as they flee befor
swash, then chase the backwash of each breaking
Actually, this is maneuvering to catch crustaceans b
they can burrow out of sight or "disappear" by si
perfectly still and blending with their background.
ring gulls, too, haunt the area, eating clams and dead
washed up by the sea.

Inland from the shore, above the reach of high
and storm waves, is a zone composed of the sand that
been blown there by gentle ocean breezes or by how
northeasterly gales. This zone is characterized by d
and hollows that combine to form an unending variet



Old dredging mound was selected by black skimmers for a nesting site. From here they patrol bay waters for minnows.

phic patterns. The sparse vegetation bordering the s composed primarily of dune grass, or marram *Ammophila breviligulata* with a sprinkling of other such as beach heather *Hudsonia tomentosa,* dusty *Artemisia Stelleriana,* and Virginia creeper *Parthe-s quinquefolia.* Dune grass is especially well l to this desert-like, unstable habitat. Above , its stems and leaves reduce the velocity and carry-acity of surface winds and cause the deposition of elow ground, its rhizomes and roots form an intri-ice, which helps bind the sand into place. Many of est dunes in this zone are composed of successive f sand held in place by past generations of dune arther inland, where sand movement is less pro-l, the low, sprawling cushions of beach heather stabilize the surface.

small animals that make their homes in these dunes also well adapted to the special features of their The pale wolf spider, of the Lycosidae family, for , sits patiently inside its burrow in the sand, ready ce on unwary insects that pass by. Its coloration vith the environment and, instead of spinning e spider catches its prey by speed and remarkable

Ghost crab emerges from burrow when tide falls and darts after food. When it stays still, it is perfectly camouflaged.

Birdbanding is conducted on Island Beach by New Jersey Audubon Society. Bird was caught during summer census.

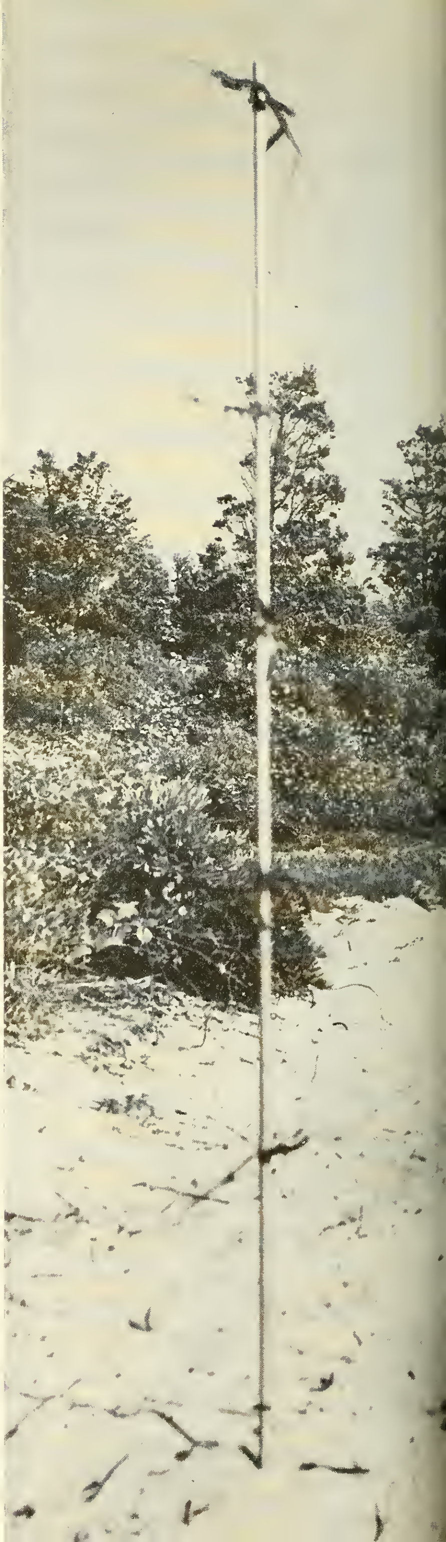
strength. The seaside locust, *Trimerotropis maritima*, is another dune-dweller that blends with the sand. It feeds on dune grass and other plants in the area.

Farther inland, dune grass and beach heather give way to a vegetation dominated by woody plants. Bayberry, black cherry, beach plum, highbush blueberry, American holly, red cedar, poison ivy, and many other species of shrubs and low trees are intertwined and laced together by Virginia creeper and the thorny greenbriar to form low, impenetrable thickets. Low at their seaward edges and sloping gradually to as high as fifteen feet to landward, these thickets—pruned and sculptured by salt spray—present a distinctive, streamlined appearance.

Taller thickets and woodlands can develop only on sites protected from spray-laden winds by their distance from the shore or by intervening dunes. Woodlands dominated by red cedar *Juniperus virginiana* or pitch pine *Pinus rigida* are primarily confined to the northern part of the park. These have the richest flora and fauna of any of the forty-odd community types represented in the area.

Such thickets and woodlands provide the cover for large populations of rabbits and a variety of bird species. The abundance of rabbits may be attributed, in part, to the scarcity of foxes and other predators. The few foxes that live in the area, as well as marsh hawks and other birds of prey, find it both difficult and hazardous to hunt rabbits in the thorny vegetation they use for cover.

Although it is only half a mile from the ocean, the western shore of Island Beach, facing Barnegat Bay, presents a vastly different countenance from the eastern side. In some places, there are narrow strands of sand strewn with a water-soaked eelgrass *Zostera marina*, the breeding place of countless biting flies. Behind the sand strips are



Nearly invisible nets are strung across movement routes of birds, which are usually caught during morning feeding.

Following identification and banding, birds are released unharmed. Mesh holds them gently while bander takes notes.

low, grassy dunes. In other places, the bay shore is bordered by tidal marshes whose vegetation is characterized by salt grass *Spartina patens* and a small, fleshy samphire *Salicornia virginica*, whose Latin name—from "saline"—indicates its adaptability to its environment. On the bay shore and just above the high-tide boundary of some of the tidal marshes are great stands of reed grass *Phragmites communis* that blanket the Jersey flatlands farther north. From late spring to early fall, the air over the marshes swarms with mosquitoes. Ditch banks are riddled with the burrows of fiddler crabs, which fall prey to raccoons, great blue herons, and other shore birds.

Certain factors appear to be especially important in forming each of the five recognizable plant communities on Island Beach. Of these, the distribution of salt spray is one of the most apparent. The intensity of the spray, which is windborne inland and deposited on the exposed parts of plants, is greatest near the ocean shore and decreases farther inland. Dune grass and a few other species are tolerant of salt spray, but most herbaceous and virtually all woody species are severely damaged or killed by exposure to spray in large amounts. Only inland, where spray intensity is reduced, can woody species become established and grow into thickets.

Tree twigs that are exposed to spray are killed and terminal growth is suppressed. Thus, shrubs and trees alike are pruned to about the same height and molded into dense thickets, which grow very slowly and never seem to develop into woodland or forest. In more protected sites, the ground level effect of spray on trees is negligible, but taller trees, especially in open spaces, have deformed crowns that appear to reflect the influence of the salt.

The varied face of Island Beach, by its constant flux, is made even more expressive of the laws of nature. Waves reshape the shore. Winds rearrange the patterns of dunes, and plants modify the work of the wind. Salt shapes the plants into characteristic forms, and plant communities

A GREAT WINGSPREAD—as much as six feet—characterizes the osprey, an eagle-sized hawk that patrols the bay shores and inland ponds for fish. When fishing, it flies hig spot its prey, then rockets down to the water to seiz

change the physiognomy of the landscape. Sometimes the innate forces of nature and the growth of plants combine to change the shape of a piece of land, setting off a chain reaction that completely alters both the physical and the biological characteristics of a habitat. For one example, Barnegat Bay usually freezes over in winter, and the expansion and erosive action of the ice—first freezing and then breaking up in the spring—throws up low ridges of sand mixed with eelgrass and silt. When these ridges are stabilized by the growth of pioneering reed grass, they form effective dams against tidal flooding. If this process occurs along the bayward edge of a tidal marsh, further saline inundation is prevented. The salt already present is slowly leached out by rain, and the soil solution from which the plants draw their water and mineral nutrients gradually changes from salty to brackish to fresh. Eve the early stages of this evolution, the changing marsh provide niches for the marsh mallow and various o plants that are unable to grow in highly saline s

Later, small fresh-water ponds may be inhabited leopard frogs, which cannot tolerate saline waters. E tually, these once-salty, grassy marshes may develop thicket or woodland communities with an entirely di ent combination of plant and animal occupants.

THE great diversity and perpetual changing of Island Beach landscape and biota present the pro sional ecologist and the amateur naturalist with a m tude of lessons, mysteries, and quandaries. Within relatively narrow boundaries are packed a fascina array of plant and animal communities virtually u fected by the activities of civilized man. Being thus uni it is of inestimable value for the enjoyment or stud the myriad forces that have shaped our coastal la

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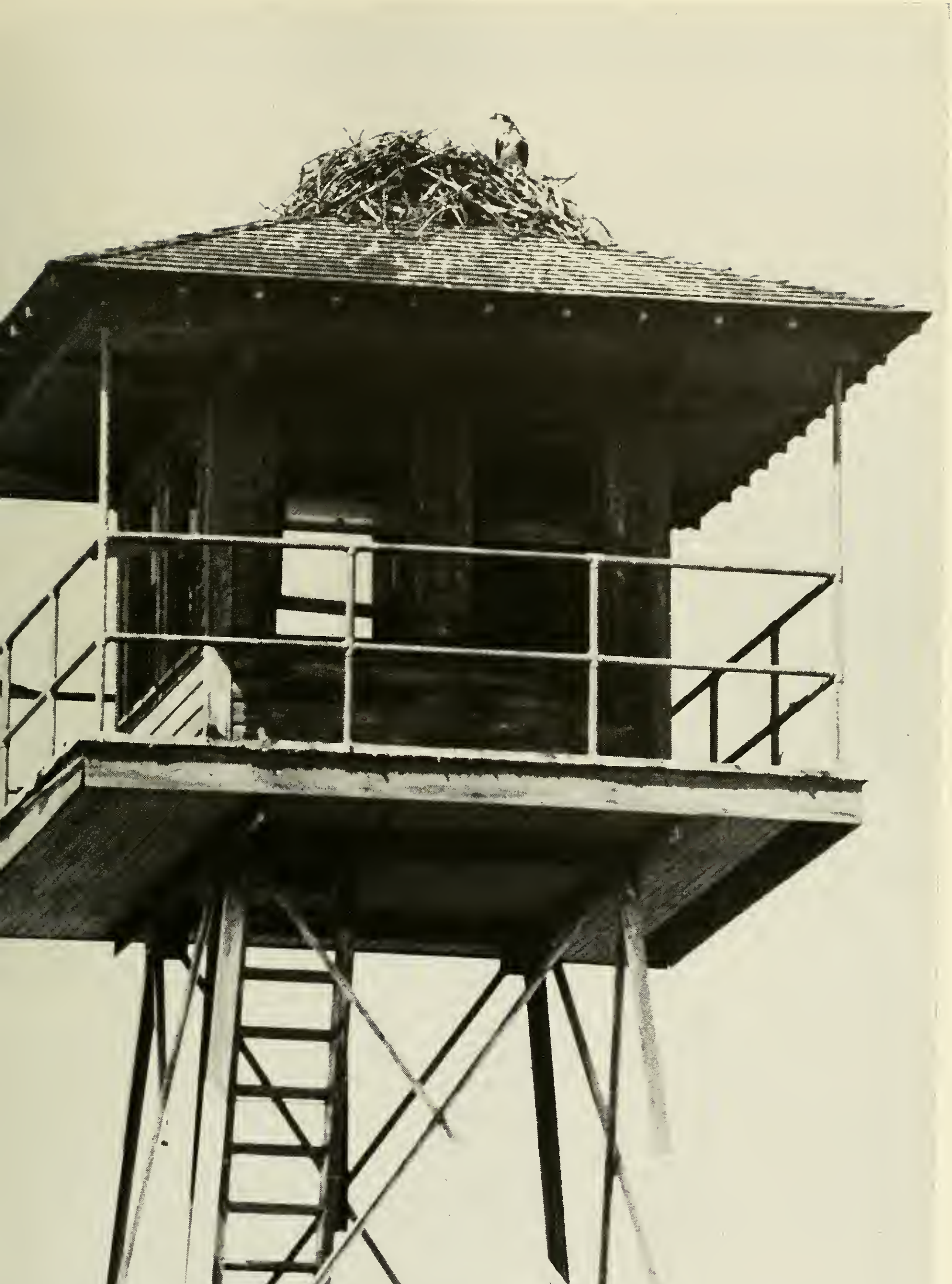
DR. MARTIN teaches botany at the University of Minnesota and has conducted considerable research at Island Beach.



TOWER near ocean shore has been popular nesting cores of osprey, which, in the absence of big trees, will take advantage of almost any available support. Young may remain in the nest for as long as six or seven weeks.

Gluttony with good reason

Some honey ants become living reservoirs

By Ross E. Hutchins

The various ways that animals have solved the manifold problems of life are a source of constant interest to students of nature, and often shed light on the evolution of particular activities. Noteworthy in this respect are the ways of the social insects—the ants, bees, and wasps—whose life patterns reveal some of the most remarkable adaptations in the animal kingdom. Honey ants, which utilize a distinctive method of solving the food storage problem, present a particularly interesting example of such specialized adaptations.

Several species of ants possess well-developed, characteristic methods of storing food. Harvester ants, for instance, gather seeds, which they store in "grain bins" beneath the surface of the soil. But the storing of a liquid food, such as honey, presents difficulties. Bees store their honey supply in cells formed of wax; but honey ants are not endowed with the ability to secrete wax. How, then, can they store such a fluid material? Their solution to this problem is an ingenious one.

The recorded story of the honey ants goes back more than a century—to the year 1832, when the first account of the insects was published by Dr. Pablo de Llave in a Mexican scientific journal. Dr. Llave obtained his information at second hand from a person living in Dolores, a village near Mexico City; but while his information about these ants (known there as *busileras*) was indirect, he described their activities with surprising accuracy, and in some detail.

The honey ants received occasional notice in scientific journals after their initial description by Dr. Llave, and in the summer of 1879, Henry Christopher McCook, a Presbyterian minister, made a trip to the American West for the purpose of studying the ants in their habitat. Dr. McCook was a prominent contributor to ant lore, having previously made extensive investigations of the harvester ants that populate the Great Plains.

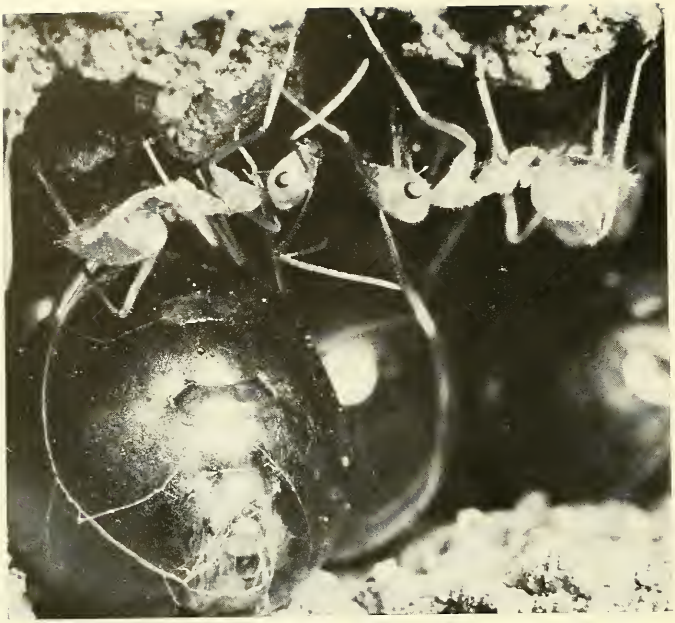
McCook arrived at Manitou, Colorado, in July, 1879, on his way to Santa Fe, New Mexico, where colonies of the honey ants had been reported. By a strange coincidence—and more or less by accident—he found honey ant colonies sooner than he had expected, in the area known as the Garden of the Gods, in the vicinity of
Manitou—now a suburb of Colo
Springs. This area, which lies b
the slopes of Pikes Peak at an eleva
of slightly more than 6,000 feet,
sists of numerous exposed slab
red sandstone thrusting skyward.
slabs have been weathered into va
weird shapes, thought by some t
semble heathen deities, and from
the region takes its name.

Honey ants exist under very sp
ecological conditions, such as pr
at this locality: the soil is sand
firm enough to allow the ants t
cavate relatively broad undergr
galleries, with arched ceilings. I
here Dr. McCook found the an
onies scattered along sandy r
among the sandstone slabs.

Having thus located his qu
McCook erected his tent in the
below the junction of Adams and
Hagen ridges in order to stud
insects and record their story.
investigations resulted in a class
count of the habits of honey
which was published in 1882. W
in 1958, the present writer visite
Garden of the Gods area to tak
photographs on these pages, he f
the locality little changed from it
dition of 1879. In fact, it was po

Scrub oak gall, *above*, is source of nectar gathered by worker honey ants.

At right, a balloon-like, ant "re
clings to underground gallery c



Golden-yellow worker ants of normal size, above and at right, mingle with "repletes." Some of latter have fallen to floor because of nest disturbance.

to locate, within a few yards, the site of Dr. McCook's camp, made some eighty years before.

Growing on the sandy slopes of the Garden of the Gods are numerous scrub oaks that support large numbers of galls, formed through the activity of certain tiny gall wasps. During the summer these galls, which resemble small marbles, secrete honeydew upon their outer surfaces. The honeydew is secreted mostly at night, and it is then that the yellow ants stream forth from their underground tunnels and imbibe the sweet drops of moisture.

The worker ants leave their nests at about seven-thirty in the evening—which, during summer, is approximately the time of sunset—and the return trip toward the nests begins at about midnight. By dawn, almost all the foragers are safely back in their subterranean nests. When they leave the nests in the evening, the workers have abdomens of normal size, but on the homeward journey their abdomens are distended with loads of the amber-colored gall nectar.

Arriving at the nests, the loaded worker ants "feed" their nectar to certain individual worker ants that serve as "storage tanks" for the colony's food supply. As the nectar-harvesting season progresses, the abdomens of these individuals become so distended that the insects can no longer walk about normally, but hang suspended by their legs from the ceilings of the galleries that form their nests.

As these ants' abdomens slowly expand with nectar, the membranes between the segments stretch until the sclerites (the plates covering the abdomen) become reduced to mere ovoid islets on a spherical surface. The engorged ants cling to the arched ceilings of the tunnels, and it is said that if one falls, it is helpless, being unable to regain its suspended position. This, however, is not an established fact: the writer observed that the sister workers of such ants appeared to make an effort to help them recover. Further study is needed on this point.

The engorged individuals are called "repletes." If one is dropped as far as two inches, its abdomen may burst. In the nest, however, this does not often occur, since the fall is seldom more than half an inch or so. Dr. McCook weighed a number of the normal workers, and found their average weight to be 0.048 grams. He also weighed the honey from the repletes' abdomens, and found that it averaged 0.3942 grams. Thus, the store of ho
in an engorged specimen averaged
times the ant's weight.

Dr. Hutchins, presently head of th
Department of Zoology and Entomo
ogy, Mississippi State College, is al
a well-known writer and photograph
in the field of plant and animal lif

The storage of honey or necta
the abdomens of various
seems a logical solution to a b
problem: the safe storage of a li
food over a long period of time.
cordingly, it is not surprising tha
find many sorts of honey ant
other parts of the world—Australia

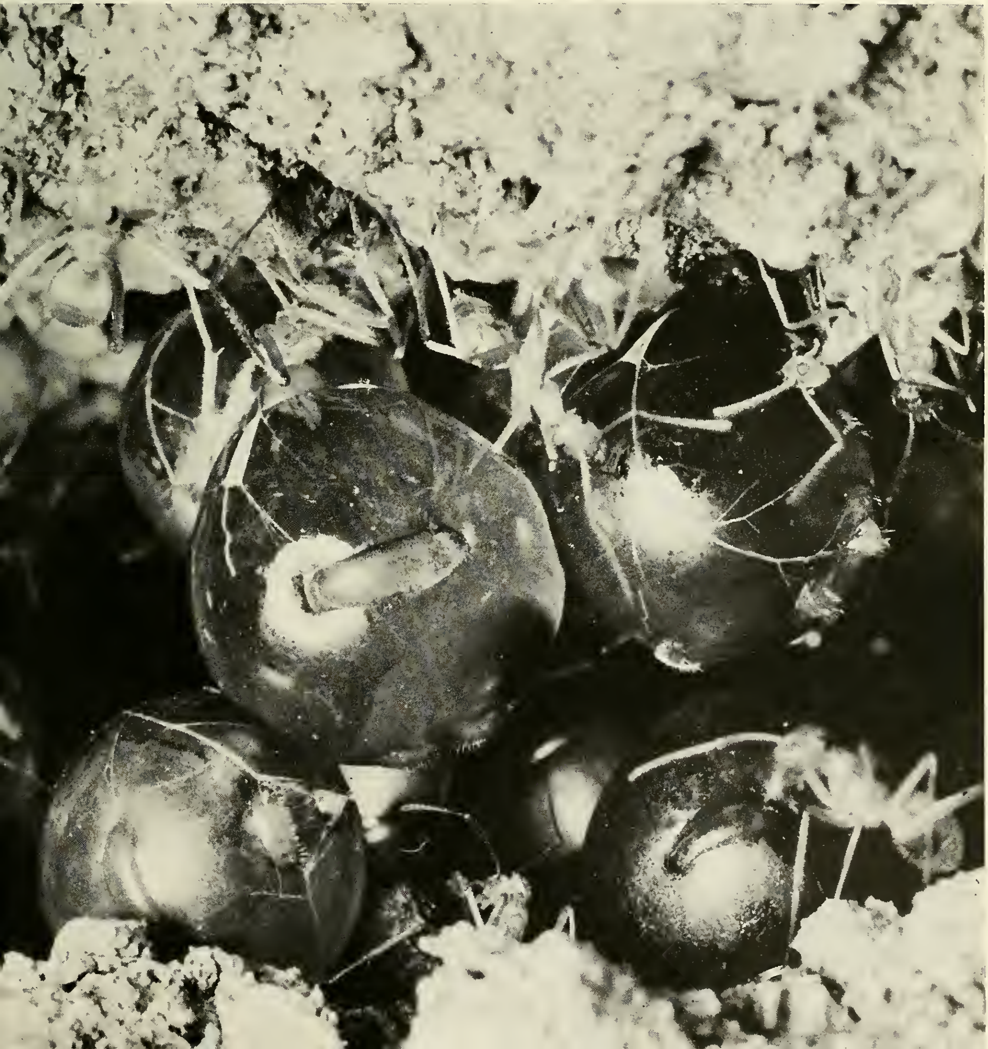
ca, for example. They are not, ever, as spectacular in their honey- ing habits as those of the American hwest and Mexico; and it is worth ng that the honey-storing ants else- re in the world are not closely ed to our own.

n the United States, itself, there is her quite widely distributed ant— e genus *Prenolepis*—that also pos- s the honey-storage habit, but in a r degree. *Prenolepis* workers are n seen crawling about with their mens considerably distended with ydew gathered from aphids or t lice. These workers, however, r imbibe sufficiently to render n incapable of movement, as is the with many of the workers in every well-established colony of *Myrmecocystus horti-deorum*, as the Garden of the Gods honey ant is known under its scientific name.

It has never been established how certain workers happen to become repletes, rather than foragers, but it is a fact that there may be up to three hundred of them in the nest galleries. Here, in the darkness, the repletes hang month after month through late fall, winter, and early summer. Now and then other ants visit them and receive regurgitated honey from their mouths; but otherwise their lives are without incident. After assuming their roles as living tanks, they never again see the light of day.

Indeed, the repletes are the ant colony's sole source of nourishment during much of the year—for the region is without sufficient moisture to produce nectar-bearing flowers, and the oak galls do not produce honeydew until midsummer. Except during this one brief period, then, workers, queen, and young must all look to the repletes for their sustenance. During winter, the colony is dormant; and the repletes, deep in their galleries, remain safe from the frost.

The southwestern United States is an exacting environment, providing extremes of temperature as well as of drought. Among the creatures to be found in this harsh region, few can be better adapted than the honey ants.



Children of the Forest

Thus the Pygmies aptly name themselves

By Colin M. Turnbull

Just to the west of Africa's Ruwenzori Mountains lie the many thousand square miles of the Ituri Forest, a tropical rain forest that covers much of the northeast corner of the Belgian Congo. Here, throughout the year, the climate is even: temperatures range between 70° and 90° F., although an average relative humidity of 95 per cent makes the nights and early mornings seem chilly and at times almost bitter. Rain comes in torrential downpours that last only an hour or two, usually in the afternoon or evening. Such cloudbursts can be expected at any time of the year, although December and January tend to be less rainy than the other ten months.

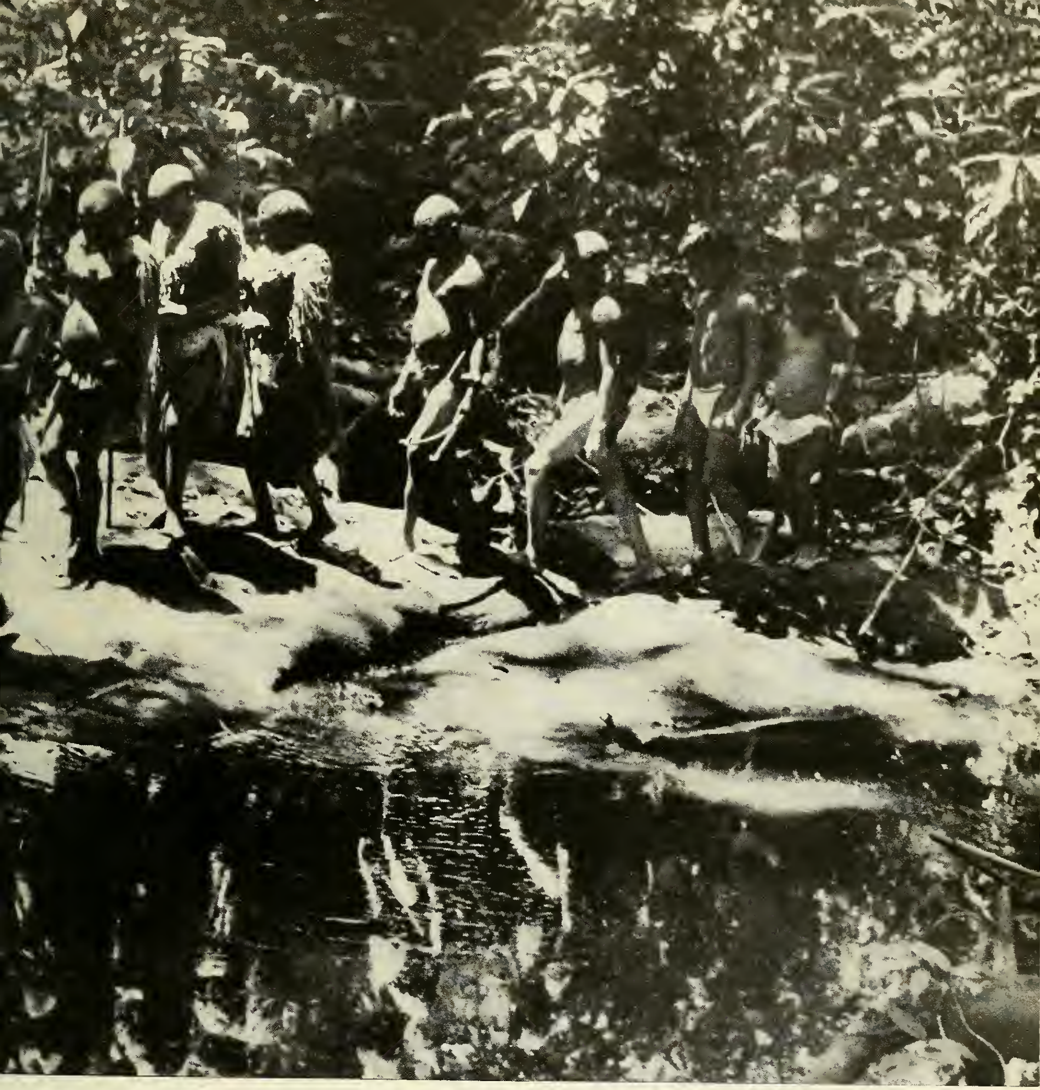
The terrain is gently undulating under its cover of dense, primeval forest. The branches of the tall trees meet high overhead and shut out the heat and glare of the sun. Toward the east, the country actually becomes mountainous, but it is possible to go everywhere on foot with relative ease. The larger rivers that meander through the forest form natural boundaries both for the wild game and for the nomadic hunting groups—the African Pygmies, known locally as BaMbuti—that wander around the vast preserve, each group in its own area, following the game and gathering the wild fruits of the forest.

The Pygmies of Africa refer to themselves as Children of the Forest, and this is not casual, primitive poetry but a very realistic self-appraisal. A child is dependent on his parents for all the necessities of life—food, warmth, shelter, clothing, protection. The BaMbuti are conscious of exactly this dependence on their forest home. They sing to it, talk to it, dance to it; refer to it as Mother or Father or Friend. One night, as an example, I heard a noise from a clearing just behind the BaMbuti hunting camp where I was living. I went to see who it was because usually, at night, the Pygmies do not leave their huts. The sound was being made by a young friend of mine, a youth called Kenge: he was dancing in the moonlight all by himself, with a flower stuck in his hair, singing his heart out. Kenge was one of the most incorrigible flirts I knew, so I jokingly asked him why he was dancing alone. He looked at me in surprise: to him this must have seemed an exceptionally stupid question. He answered: "But I'm not dancing alone . . . I'm dancing with the Forest, I'm dancing with the Moon."

This Pygmy feeling of closeness to the forest and intense affection for it, mingled with a sense of dependence, can best be understood by a look at the way these people live their daily lives and how they are influenced, if not governed, by their environment. Perhaps the forest's most powerful influence, and the way in which it is most strictly limiting, derives from its very self-sufficiency. The endless miles of the Ituri offer the Pygmies everything they need—at a simple but fully satisfactory level. The forest is a world of its own, sufficient and complete; a static world, yet an extraordinarily vital one. Its people—nomadic hunters and gatherers—live one of the earliest forms of life known to man.

There are isolated groups of
mies and Pygmoids today in diffe
parts of Africa's great equatorial
est belt from the Ruwenzori M
tains right across to the west coas
span of about 1,500 miles. The
Pygmies, the BaMbuti, which o
these groups seem to have resi
any change or acculturation pro
most successfully, today num
about 40,000. A BaMbuti family
feed itself simply by setting off in

Mr. Turnbull has spent considerable time documenting the Pygmies on film and on records. He studied at Oxford and London Universities, and is on the staff of The American Museum.

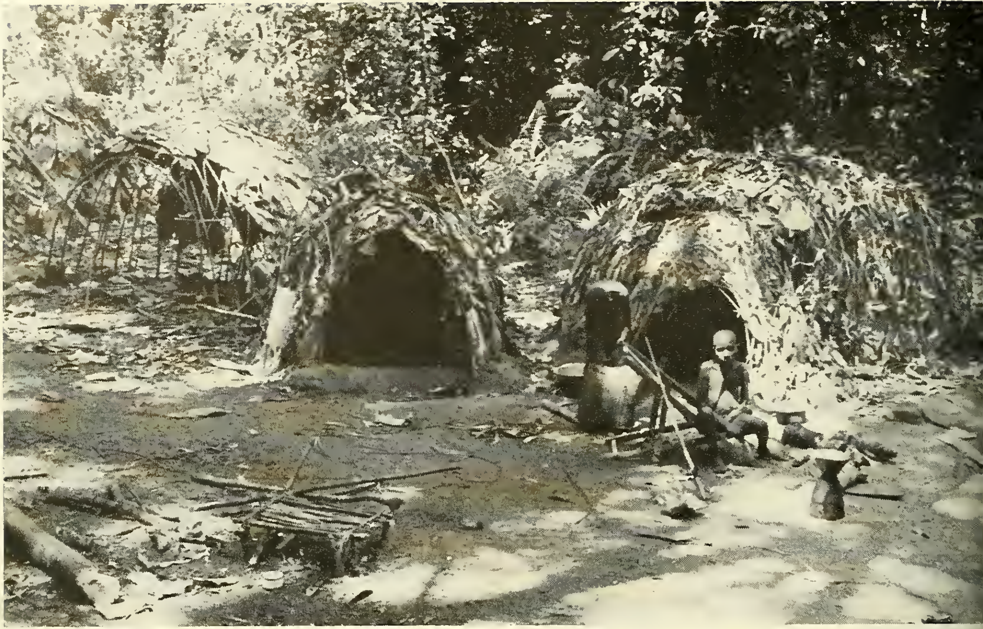


TO HUNTING SITE, vigorous, middle-aged men carry
men and children are armed with bows and arrows.

Nets are laid end to end, joined with those of other units of the group. When catch is made, all converge for the kill.

: the father, helped perhaps
ons if they are old enough, to
me with bow and arrow or
ne mother and young girls to
ome of the many varieties of
ms, nuts, edible roots, and
hich are never far away. The
s such—and is further eked
easonal crops, such as honey,
and certain kinds of grubs
ere is no need to store food
lean seasons. Hunting and gathering is a daily activity. If one day's hunt brings in an exceptionally large amount, then the following day will be spent lazing in the camp, doing the few odd chores that gradually accumulate—the making of new bows and arrows, or the repair or lengthening of hunting nets, where these are used.

One almost constant activity is the making of bark cloth, and any hunting camp can be detected from a great distance by the sharp sound of hammering as bark is flattened out against a fallen tree trunk with an ivory beater. The whole bark is first stripped from a tree, the outer bark removed, and the inner bark then softened either by soaking it overnight in a stream or by smoking it over a fire. Sometimes the inner bark is left in a special mud that dyes the material blue. When beaten with a mallet—usually made from the butt of an ele-



Clusters of huts form a Pygmy camp, in which each family group is set slightly apart from the next. Deserted hut at far left was probably used by visiting relative. After departure, a few leaves were removed to repair other l

phant tusk but sometimes from wood —the fibers spread out to form a soft cloth that, after drying, is either worn as it is or decorated with simple dye patterns drawn with the finger.

Most of the BaMbuti hunters on the eastern edge of the Ituri Forest use bow and arrow or spear, not nets. The men go out in groups of two or three—sometimes they stay together, sometimes they split up, each following his own trail. A common technique is simply to climb a tree early in the morning and wait for an antelope to pass by. Most Pygmies are well able to imitate the sounds of the various antelope, and can call the animals within range. Some use hunting dogs, particularly for wild pig. Spears are used for protection against larger animals, such as buffalo, and for hunting elephant.

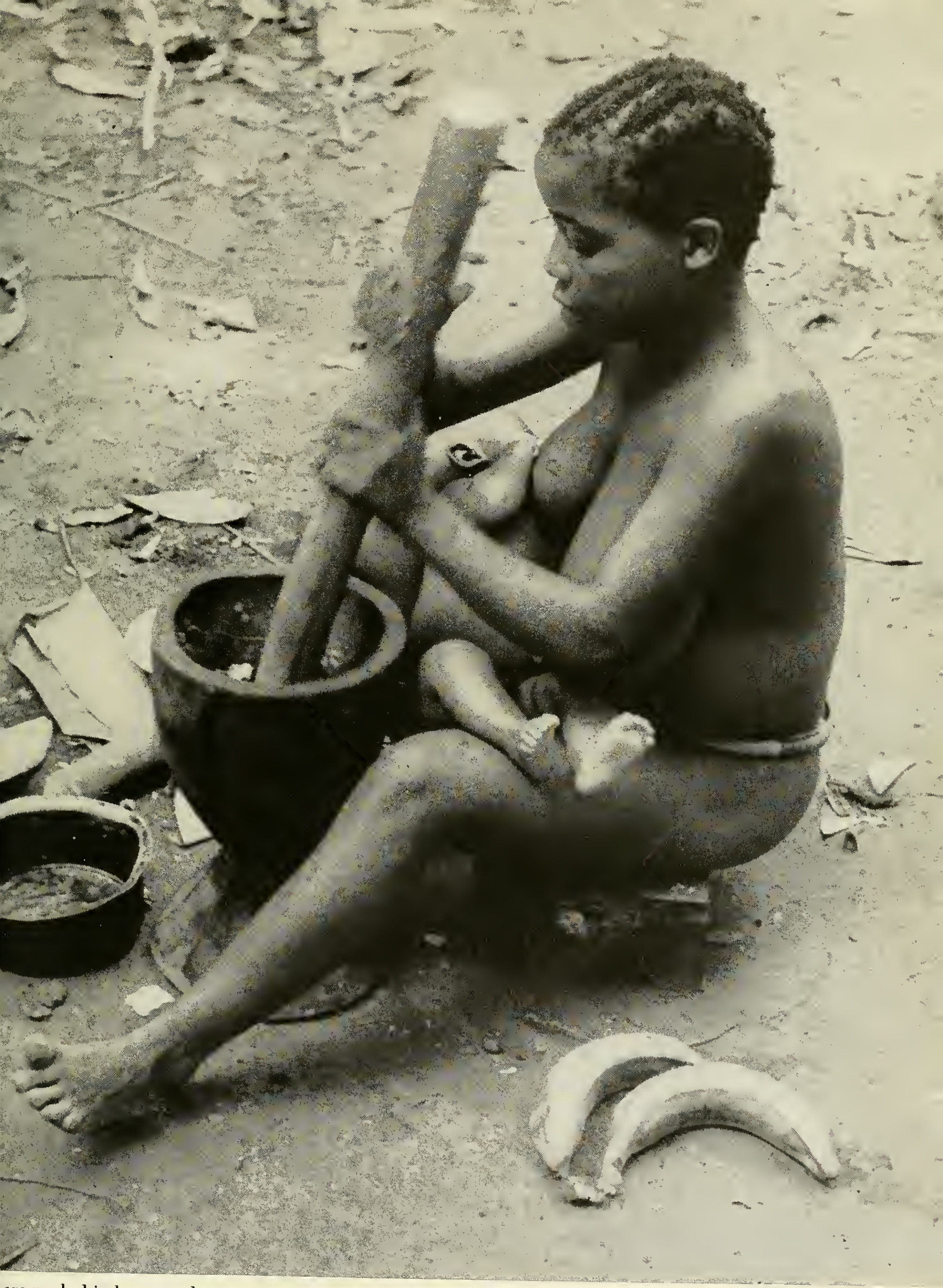
But elephant hunting is a relatively rare occurrence, and perhaps satisfies a psychological need as much as a physical one. Any BaMbuti group that wishes, because of its size or a desire for an excess of meat to barter with non-forest tribes, can get a regular abundance of meat by the use of hunting nets. In net-hunting groups, which may number as many as twenty-five families, each married man owns such a net, anything from one hundred to three hundred feet long and about four feet high, made from a local vine that has been dried, shredded, and rolled on the thigh into a strong cord.

Food is man's primary need: if the forest had denied the BaMbuti a sufficiency of food, they would either have died out or developed new techniques for food-gathering, perhaps including the principles of cultivation. But the forest did not, and they are still nomadic. Their own particular economy, at least favored if not ordained by their environment, has influenced them further in a kind of chain reaction—starting with the forest itself, and always referable back to the all-providing forest.

After a month's hunting from one camp, not only are the animals reluctant to come within easy hunting distance, but the local supply of vegetables and fruits will all have been gathered by the women. Daily, the food-gatherers will have to wander farther and farther with diminishing results. In addition, with no effort toward garbage disposal and little idea of sanitation, a Pygmy camp beco
mildly unpleasant to live in aft
month, even for a Pygmy. One ca
then, seldom lasts more tha
month. A decision is made to m
and early the next morning the wo
pack their few belongings into a
basket and carefully wrap a glow
ember from their hearth in a he
fire-resistant leaf. The men,
spears and bows and arrows at
ready, carrying their hunting ne
they have them, lead off, others s
ing behind as rear guard.

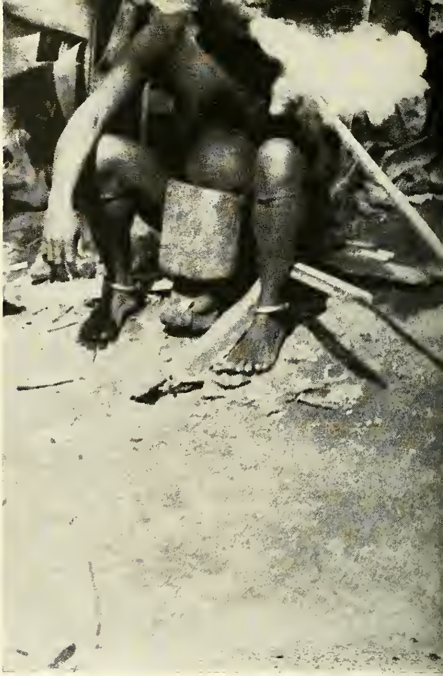
In deciding how far and in wha
rection to go, the Pygmies are
fluenced by their knowledge of
game and its migratory tenden
They are also limited by nat
boundaries, particularly those for
by the larger rivers, which they h
no means of bridging. It is an inte
part of Pygmy life that he recogn
and he accepts the boundaries that
ture has set on him and on the g
he follows through his territory.

This nomadism in turn has its
effects, necessitating, as it does
minimum of permanent possessi
that will have to be carried fr
camp to camp. Pygmy material



are mashed in large wooden mortars with greens, herbs, and are then wrapped in edible leaves and roasted. In the forest, other fruits are substituted for bananas, which grow only in clearings near Negro villages.

Cassava preparation requires removal of poisonous peels, which are left in woven bags, then carefully disposed of.



Clay bowl fastened to end of a six- to eight-foot b
stem holds tobacco from a Negro plantation. In backgr

Four sticks, bound with vine, make seats comfortable enough to sleep on.

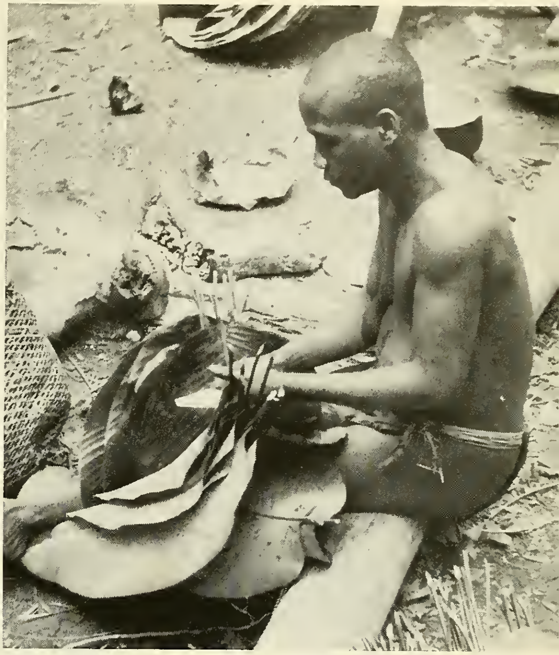
ture is minimal: many items are abandoned at each old camp and made anew at the next. Huts are built quickly and easily, using saplings bent over and twisted together to form a beehive-shaped frame, on which large phrynium leaves are hung like tiles, making the hut waterproof, yet allowing smoke to escape from inside. Beds and chairs are made equally easily from light wood, either fastened by vines to a frame or simply laid on the ground. Food is mostly roasted in or over an open fire, water is carried and drunk from leaf cups.

The simple economy of the Pygmies and their necessary nomadism naturally influence their social organization. Take, for instance, the size of the hunting groups. Regardless of whether they are net-hunters or archers, a considerable amount of co-operation is called for both on the hunt and in the general run of camp life. For both archers and net-hunters there is a minimum number of adults below which hunting becomes ineffective, and there is equally a maximum limit beyond which the group becomes unwieldy.

The BaMbuti have no syste
chiefs or councils of elders who
vital decisions for all. The lead is
by the great hunters, the younger
ried men, and the older bache
but nothing is done without ge
consent. When a dispute reache
omnivocal stage, it has become p
noisy—everyone taking one sid
the other, all shouting at once.
one of the older men, or some
even a woman, will slowly wande
the middle of the fray, quite u
cernedly. If people do not quiet d
he will give a long whistle, as is s
times done on the hunt to cal
silence. Then he says, quietly, "
must stop the noise [i.e., dispute].
are killing the Forest." This argu
is, in fact, a cogent one because
is always the danger that exce
noise will scare away the game. Bu
reference is to the forest. The dis
is then abandoned, with some g
bling, and will be patched up as
as possible over the next day or

This force toward law and o
is strong and evident enough fo
BaMbuti to exist without the fo
systems of leadership and auth
found in more complex tribes.

covered with banana leaves—a foliage the Pygmies
ly when they have made camp near a Negro settlement.



In forest, *mongongo* leaf stems are slit, *above,* hooked together and made into thatch that effectively covers huts.

ction between law and order
full stomach is obvious.

: internal organization of a
ıMbuti hunting group is, at
ght, haphazard. No chiefs, no
;, no councils: everybody.
and old, man and woman.
to have an equal say in any dis-
r problem. There is no obvious
chy, not even a kinship system
uld be said to dominate in the
l organization. Yet there is an
ıess that standing over them is
hority before which all Pyg-
ow, and in the face of which
ll know how they should be-
n any situation. That authority
forest and the way of life it
ught them—the only way they
hat makes it possible to survive
the conditions it imposes on
It is hardly surprising that we
is authority the central theme
my religious thought.

self-sufficiency of each hunting
within its own area makes
political relationships be-
neighboring groups unneces-
Here, kinship does play a role,
gh again in an unformalized
way. Among the BaMbuti, it is customary to "marry far": if pressed for an explanation, the Pygmy will often speak in terms of spatial rather than kinship distance. The basis of most groups is a number of related males and their families. Yet any Pygmy group, for one reason or another, is likely to attract strangers, who become "kin" by adoption, and the group may grow in size and complexity until it is a composite rather than a patrilineal band. At this stage, of course, marriage within the group becomes permissible.

But the general pattern and preference is still for "marrying far," and the young males will seek their wives among neighboring hunting groups. There is a series of exchange visits, first by the youngsters, then by their parents. The marriage itself, if it takes place in the forest, is an informal affair, the decision being marked by a token exchange of gifts, such as bows and arrows. More important is the fact that it lays an obligation on the group to which the groom belongs to provide a suitable girl—at some later date, if not immediately—for one of the unmarried boys in the

Elephant tusk butt is used to hammer bark cloth after fibers have softened.

Boy helps older brother string a net. If proved worthy, he will have his own.

Net, being played out through brush, is as much as three hundred feet long.

Small animal is caught in net, and a shout brings o
hunting parties to help at the kill. If dangerous, ani

bride's group. This is often called "sister exchange," a term that is only barely correct if "sister" is understood in its widest classificatory sense.

The result is that neighboring groups become interrelated through marriage. This supplies what little basis is needed for formal, intergroup contact. There is a constant interchange of visits by in-laws, establishing bonds of friendship and mutual obligation that make for a relatively easy and peaceful settlement in the event of any dispute. Such disputes as there are usually arise over trespass while huntin
gathering, and there is (or has b
until lately) little occasion for t
owing to the wide extent of
Pygmies' forest environment.

Let us look at some of the ot
ways in which the BaMb
make use of their vast forest wo
We have seen something of its g
eral effect on their social organ
tion. What about everyday life?
this level, it can be seen that the fo
does not merely make it possible
the BaMbuti to live a simple, bar

ıred from a distance. Small boys on "side lines" seize
ıimals that manage to escape through mesh of the net.

ate existence. The forest, rather,
it possible for them to lead full
omplete lives in relative com-
't not only supplies them with
fruits, and vegetables but with
different kinds of each—which
the diet full of variety. There
ıys something different to look
'd to, some rare, difficult to
but tasty animal to hunt. They
ood fashions and fads, just as
They also have their own sar-
whims. Their loincloths—made
he inner bark of various vines
ees—can be worn long or short,
with long tails hanging down behind or short frills standing up in front.

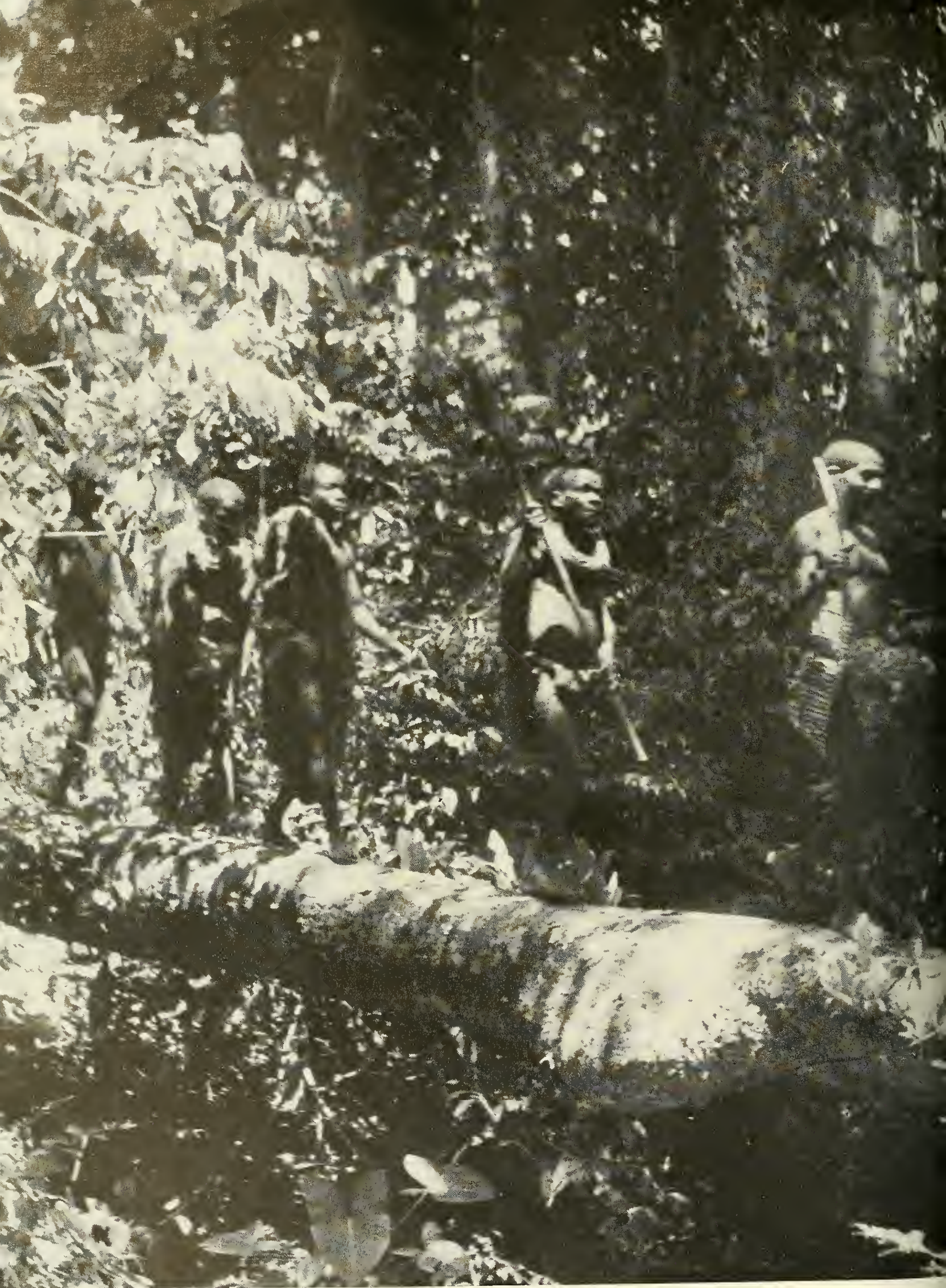
AGAIN, the Pygmies are a flirtatious and a vain people, and the forest gives them ample opportunity for all the coquetry in the world. They can make themselves resplendent by putting a single blossom in the hair. To an outsider, such a decoration may appear to be just another flower. But the Pygmies will recognize it as a rare orchid that can only be found in the topmost branches of trees overhanging certain rivers—a bloom that required perseverance, skill, and more than a little courage to obtain.

The necessities of life are not unduly hard to come by; both hunting and gathering can be strenuous, but this is no subject for complaint by the tough little Pygmies. And on good days they have all they need and are back in the camp by midday.

Although in the night and after heavy rains the cold feels intense, the forest is full of deadwood and there is never any shortage of fuel. The BaMbuti, incidentally, claim no knowledge of how to make a fire. They say that fire was given them by the forest, and they keep it burning perpetually, lighting fire from fire, always carrying embers with them, even for the shortest distance.

MOST important, however, is the fact that the forest allows the Pygmy both time for leisure and the opportunity for making something of it. The children make toys for themselves: many of these are in imitation of adult activities, but others have no such significance—spinning tops made from nuts, whistles from dried fruits, and floating darts from leaves. They

NET'S OWNER directs the cutting and dividing of meat at the capture site.



Bow and arrows are always carried by lead Pygmy in a net hunting party, who acts as the "bodyguard" for rest of the group. Another duty of the bowmen is to shoot wild fow monkeys in the event hunt for bigger game is unsucces make a variety of swings from many vines, and there is always a -by stream in which they can ly play. Adolescent youths gener- are more serious in their games, t of which serve to develop the skill will need in the hunt.

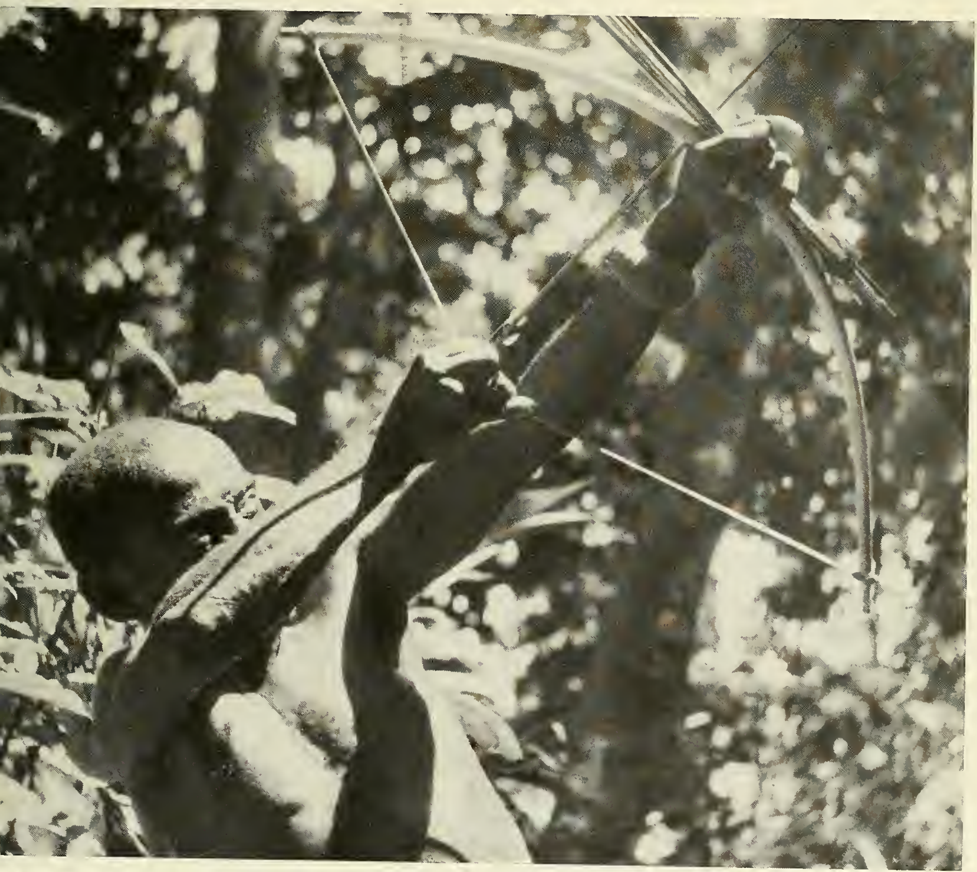
lder men and women find their sement mainly in mime, dance, song. Every Pygmy camp has its n who can re-enact some trivial lent of the day with such exag- ted posturing that he holds the tion of the entire group. Others in, and a dance will follow.

UT whether it be mime or dance or song, the subject matter is al- the same—the forest around . If someone managed to make l of himself on the hunt, this be made a subject for good-natured ridicule; but far more often the Pygmies will dance or sing about some imaginary hunt where a great hunter killed a hundred elephants. Or they will simply dance the role of a leopard, an antelope, or a wild pig, imitating to perfection each animal's movements and characteristics. They might imitate the bees that they rob for honey—perhaps the most highly prized of all the forest foods.

Honey season marks the height of Pygmy relaxation and merrymaking. It is then that one can best see the Pygmy's sharp consciousness of the world around him and his great affection for it. It was while I was with the BaMbuti during one honey season that I suddenly felt I was beginning to understand the Pygmies; that I began to know, as they knew, what their life was all about.

LIFE, for the Pygmy, is meant to be enjoyed. The forest gives him an opportunity to satisfy his needs simply; in his leisure hours he can give himself over to whatever form of recreation takes his fancy. The honey season is a time when food is particularly plentiful, and the main bulk of nourishment comes from the various kinds of honey that fill the holes in a myriad of forest trees.

Now, hunting is almost completely abandoned; all day long and far into the night the forest is filled with song and the camps are alive with dancing Pygmies. Both activities are expressions of pure joy, and even such dances as might be said to have magical significance—trying to lure the bees to bring more and more honey—are joyful because the performers know perfectly well that their magic



ED ARROWS are preferred by Pygmies, as small game e even if only slightly grazed. Bowmen always hold arrows in bow hand to enable quick re-notching as string is released. The large wrist protector is made of monkey skin.

is almost infallible. The songs say, quite simply, "The Forest is good, the Forest is kind."

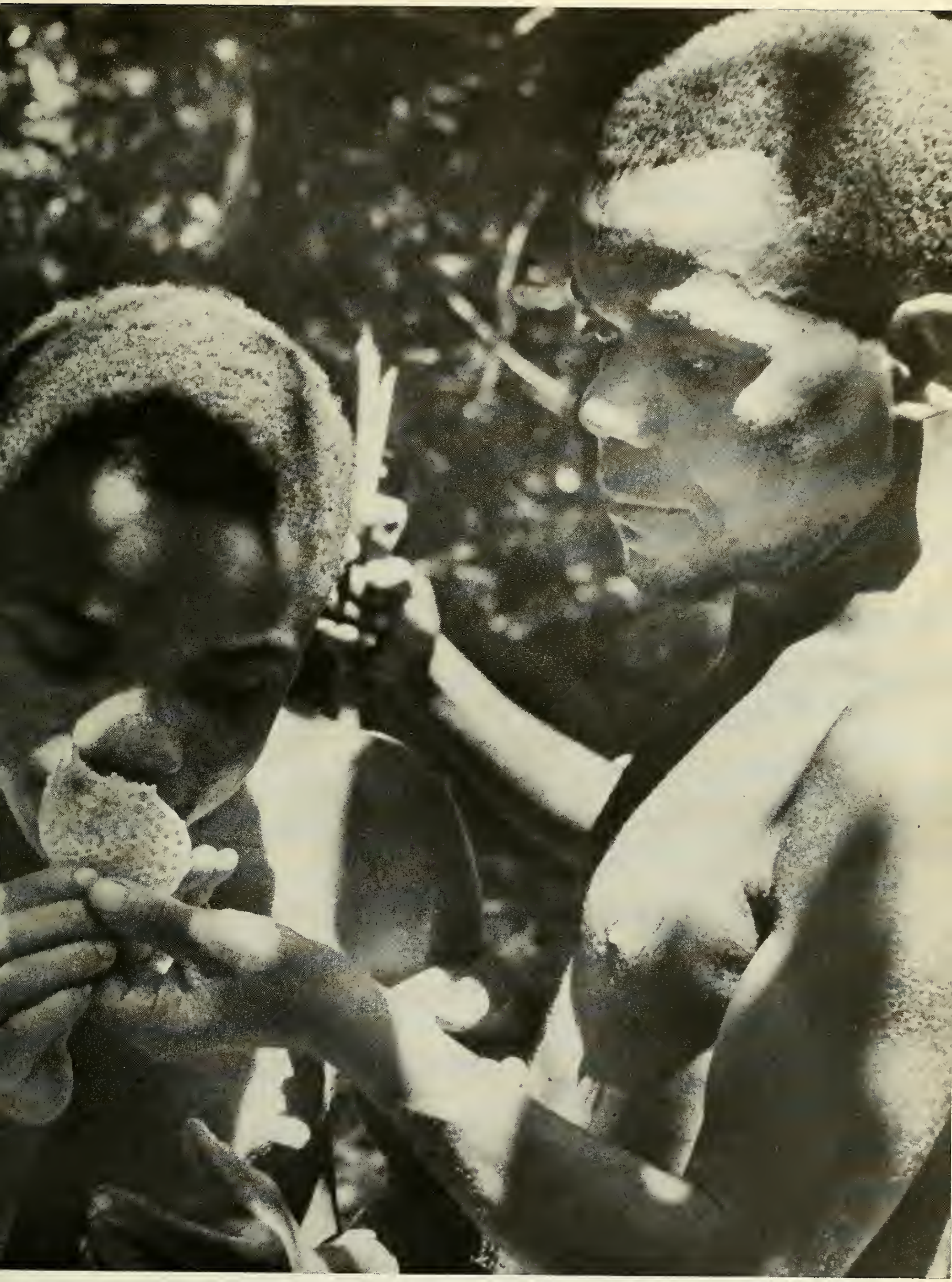
Down in the Negro villages, the Bantu get drunk when they have a holiday. That is their way of enjoying themselves. Their dances are not dances of joy. When something goes wrong in the Bantu village, the sorcerer is called to cast his spells, and hardly a day passes without his being summoned. Theirs is a hard world and full of evil. The forest is hostile and makes life painfully harsh for the plains-loving Bantu.

Deep in the forest—if life goes well and easily, as it usually does—the Pygmy sings his joy. If something does go wrong, he sings his faith, an unshakable faith, that the great god, the Forest, will soon put it right. And the Forest always does.

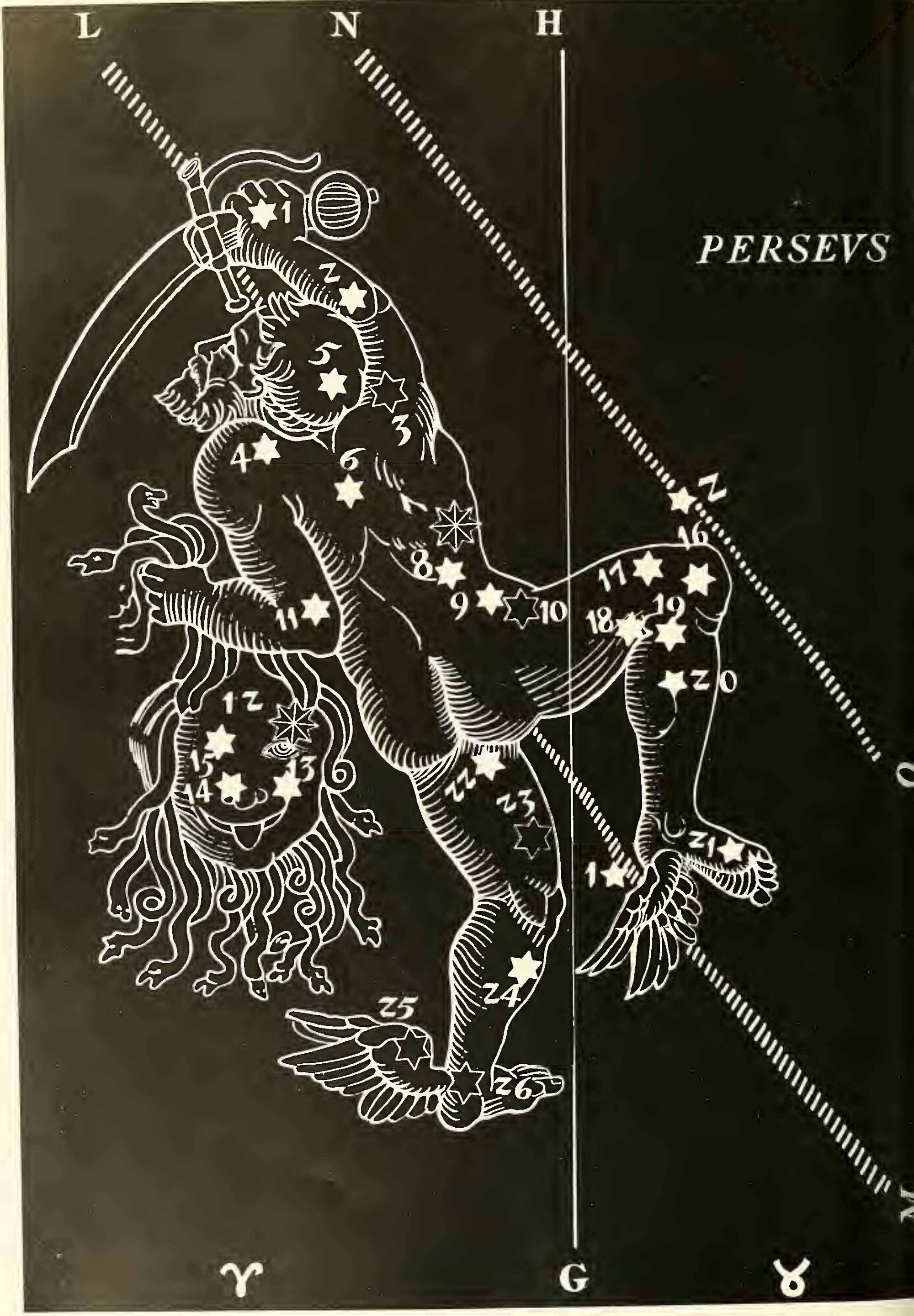
(To be concluded in October.)

Honey is staple of Pygmy diet. Here honey adz is used to widen hole, thus facilitating removal of comb. Bees smoked out by coals wrapped in lea

Handfuls of honey are pulled from hole after bees are smoked out. When hole is high in tree, one Pygmy removes honey, eats a bit, and throws rest to his friends, who below. Leftovers are leaf-wrapped and taken back to



Y is usually eaten fresh, comb and all. However, if ll of foreign matter, comb is put in a leaf, soaked in water, and the water drunk eagerly. If there are white, fat larvae in the comb, it is especially prized by Pygmies.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SKY REPORTER

The spectroscopic binary that is Medusa's right eye

By Simone Daro Gossner

HE variable star called Algol, in the constellation of Perseus, is as much a linguistic puzzle as it is an nomical one. In the illustration, *left*, it is the left eye edusa, but this picture has been drawn as it would ar on a celestial globe. In the sky, which is seen from e this imaginary celestial sphere, Algol appears, of se, as Medusa's right eye.

ymologically, the name of Algol is derived from the ic *al-ghul*, a female demon. The association of this with the fearful Gorgon of the Greeks and the no-less-tening ghoul of the Arabs has led many historians of nomy to the belief that Algol's variability was already n to Ptolemy and his predecessors. This is open to derable doubt. There are no records of any kind, in my's Almagest or elsewhere, that a change in Algol's tness had ever been noted. It has also been suggested the star's location in the head of Medusa was a mere idence and that *al-ghul* was the nearest equivalent edusa in Arab folklore. Disappointing as it may be, xplanation is the most plausible one.

e first observation of the variability of Algol (known as Beta Persei) is credited to the Italian astronomer anari, who published a pamphlet on this subject in . On the other hand, the periodic nature of the phe- non eluded him—and his successors—for more than tury. On November 12, 1782, an eighteen-year-old shman, John Goodricke, observed the first minimum e star's brightness. The boy was a deaf-mute who had oped a genuine skill in astronomical observation. In ourse of the next six months, he kept a fastidious d of the fluctuations in Algol's magnitude and noted complete regularity. He communicated his findings e Royal Society with the comment that, in his view, eriodicity of the light-curve might be caused ". . . by terposition of a large body revolving around Algol."

IE possibility of a physical connection between the omponents of certain double stars had been already sted by the Rev. John Mitchell in 1767. Nevertheless, ricke's interpretation met with considerable resist- at first. William Herschel, in particular, could not nvinced that Algol might be a double star—he had seen it thus in his seven-foot telescope.

other century elapsed before the duplicity of the star inally established, by means of the spectroscope. Any cement of a light source in the line of sight is accom- d by a corresponding shift in the lines of its spectrum rainbow pattern obtained by dispersing its light gh a prism)—toward the red if the source is receding oward the violet if it is approaching. In the case of tars revolving around each other in a plane tilted to the line of sight, each component would alternately recede from and then approach the observer, with the attendant oscillation in the position of its spectral lines. In the case of Algol, this effect was observed by H. C. Vogel in 1889. Such systems, in which the two stars are too close to each other to be separated by the telescope, but which reveal their dual nature in the behavior of their spectrum, are known as spectroscopic binaries.

PERIODIC fluctuations in the brightness of Algol are caused simply by the fact that, as the two stars revolve around each other (it would be more accurate to say that they both revolve around the center of mass of the system), each one, in turn, eclipses the other. When they are side by side, the observed magnitude reflects their combined brightness. But, whenever one is eclipsed, the brightness of the other alone is seen. In actual practice, the phenomenon is somewhat more complex, because the plane of motion of the two stars is tilted to the line of sight and their eclipses are only partial.

All that is known about Algol has been inferred from elaborate studies of its light-curve and spectrum, and from a knowledge of its distance from earth. These two eclipsing stars are quite dissimilar, one being about thirty times as bright as the other. The mass of the fainter one is equal to that of the sun, and its radius is 3.8 times the solar radius. The other is more than five times as massive, but its radius is slightly smaller than that of its companion. Their mutual distance is less than a tenth of the earth's distance to the sun. Such proximity induces strong tidal effects which distort their shapes. Their period of revolution is 2.867 days: in view of their closeness, this is believed to be also their individual period of rotation. There is no doubt that such fast rotation causes a certain amount of flattening in both stars.

Algol's binary system does not account fully for all observed data. Certain irregularities in the period of the light-curve can be explained only by assuming strong perturbations by a massive but invisible third body, having a revolution period of 1.873 years. Yet we encounter a contradiction. The length of this revolution period implies an angular separation of the third body from the rest of the system large enough to be resolved by existing telescopes. But no third body has ever been seen, in spite of the fact that a star sufficiently massive to cause the observed perturbations should, in general, be bright enough to be visible from the earth. The only assumption fulfilling both conditions is that the third star in the Algol system is a white dwarf, one of the tiny but very massive stars to which class Sirius' companion also belongs.

Only one puzzle remains in the story of Algol and other systems of its type. Current theories on the formation of stars indicate that close binaries were probably born at the same time, in the same way. How then could Algol's components have evolved into such dissimilar objects?

OF SLAIN MEDUSA, with tongue protruding, is held by ed Perseus in this sixteenth-century German woodcut.

THE SKY IN AUGUST AND SEPTEMBER

From the Almanac:

Full Moon	August 6.	9:41 P.M., EST
Last Quarter	August 14.	12:37 A.M., EST
New Moon	August 22.	4:16 A.M., EST
First Quarter	August 29.	2:23 P.M., EST
Full Moon	September 5.	6:19 A.M., EST
Last Quarter	September 12.	5:20 P.M., EST
New Moon	September 20.	6:13 P.M., EST
First Quarter	September 27.	8:13 P.M., EST

The autumnal equinox will occur on September 22 at 8:00 P.M., EST. At that instant, the sun will cross the celestial equator on its southward journey.

For the visual observer:

Mercury's greatest western elongation on August 5 will place it very suitably for observation in the early part of August. During that period, it will rise nearly ninety minutes before the sun and will be seen low over the eastern horizon. In the following weeks it will be gradually less favorable. At superior conjunction on August 30, it will remain poorly placed throughout September.

Venus, very low in the west at dusk, will be difficult to see in August and most of September. On September 30, it will set one hour and a quarter after the sun.

Mars will rise in the east at midnight, local standard time, on August 1, 11:00 P.M. on September 1, 10:00 P.M. on September 30. It will be overhead at dawn during all of September. Located in Taurus, south of the Pleiades on August 1, it will pass five degrees north of Aldebaran on August 17, and will enter Gemini in September.

Jupiter will be in the southern sky in early evening, setting at 1:30 A.M., local standard time, on August 1, 11:30 P.M. on September 1, 9:45 P.M. on September 30.

Saturn, in Sagittarius, will be twenty degrees east of Jupiter. It will set at 3:00 A.M., standard time, on August 1, 1:00 A.M. on September 1, 11:00 P.M. on September 30.

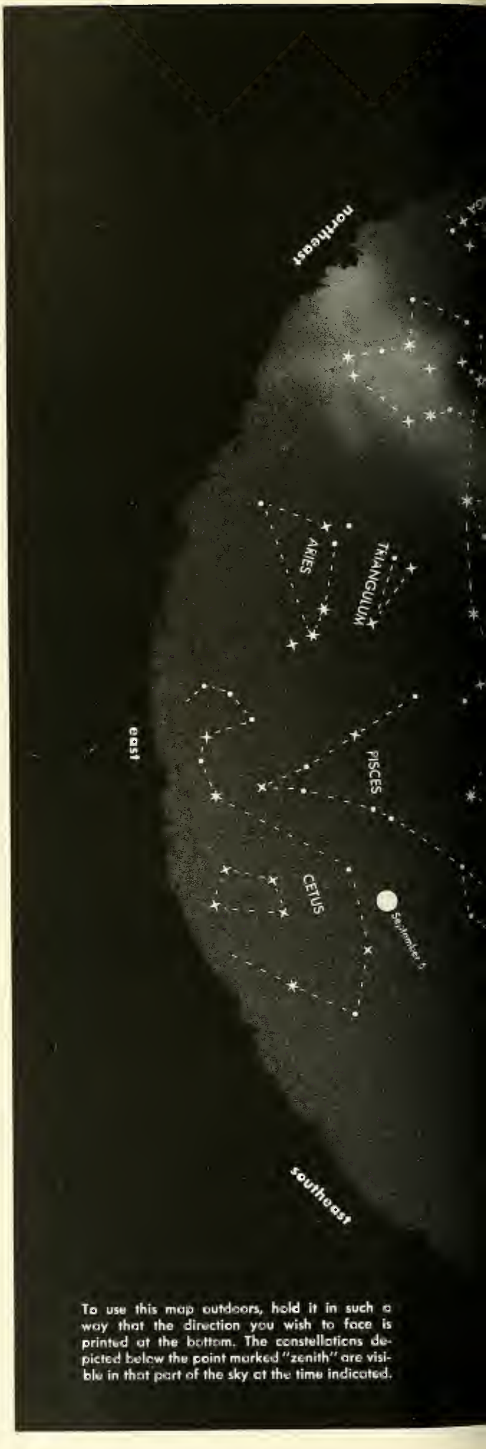
The Perseid meteor shower (July 27-August 17) will reach its maximum on August 11, but a gibbous moon on that date will interfere with observations.

Eclipses:

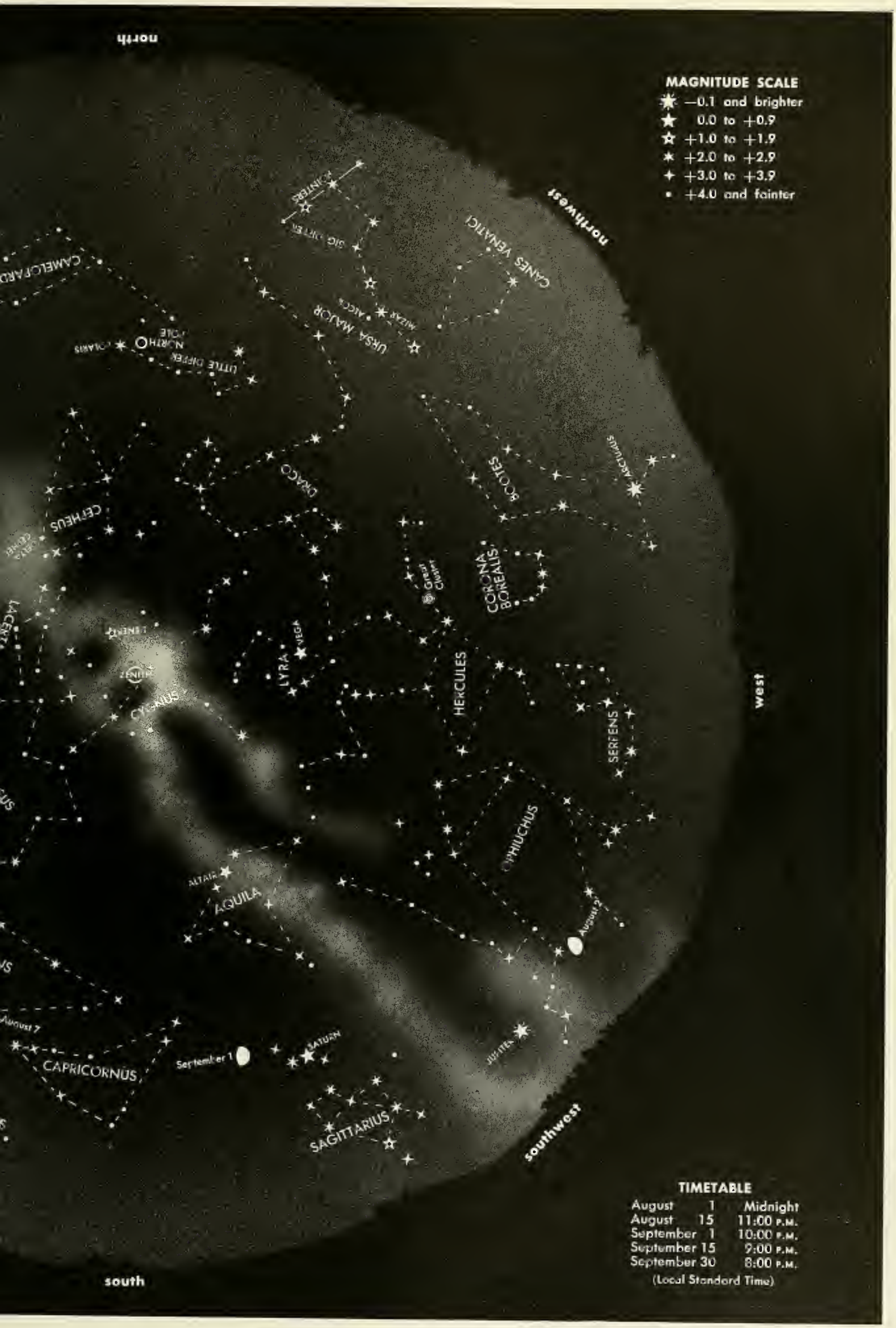
A total eclipse of the moon, visible in the United States, will take place in the early morning hours of September 5. The partial phase will begin at 4:35.6 A.M., EST, and end at 8:07.0 A.M., EST. The eclipse will be total between 5:37.6 and 7:05.1 A.M., EST. On the East Coast, the time of moonset will coincide nearly with the beginning of totality, but observers on the Pacific coast will be able to see the entire phenomenon. The magnitude of the eclipse will be 1.431, indicating that it might be a rather dark one.

The East Coast of North America will be deprived also of seeing any part of the partial eclipse of the sun on September 20. The sun will set partially eclipsed over the Central United States, but, barring inclement weather, anyone located west of the Rockies will see the entire eclipse. Maximum encroachment of the moon over the disk of the sun will be only six-tenths of the solar diameter. Observers are reminded, as usual, not to look directly at the sun except through a very dark filter, and, most of all, *never* to view it through a telescope or binoculars.

MRS. GOSSNER, a Belgian-born astronomer who studied at Harvard, regularly prepares the SKY REPORTER column.



To use this map outdoors, hold it in such a way that the direction you wish to face is printed at the bottom. The constellations depicted below the point marked "zenith" are visible in that part of the sky at the time indicated.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CAMELOPARDALIS
CANES VENATICI
MIZAR
ALCOR
URSA MAJOR
NORTH POLE
POLARIS
LITTLE DIPPER
DRACO
CEPHEUS
BOOTES
ARCTURUS
CORONA BOREALIS
Great Cluster
HERCULES
LYRA
VEGA
DENEB
ZENITH
CYGNUS
SERPENS
OPHIUCHUS
ALTAIR
AQUILA
August 2
JUPITER
SATURN
September 1
August 7
CAPRICORNUS
SAGITTARIUS

MAGNITUDE SCALE

✷ −0.1 and brighter

★ 0.0 to +0.9

☆ +1.0 to +1.9

✶ +2.0 to +2.9

✦ +3.0 to +3.9

• +4.0 and fainter

TIMETABLE

August 1	Midnight
August 15	11:00 P.M.
September 1	10:00 P.M.
September 15	9:00 P.M.
September 30	8:00 P.M.

(Local Standard Time)

Progress report on a

Modern techniques of herd management are used to insure tha

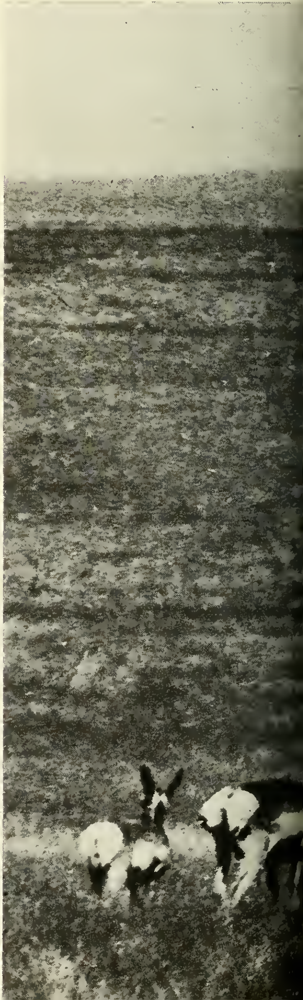
By Wendell G. Swank

When Lewis and Clark returned in 1806 from their history-making overland expedition to the Pacific coast, they brought with them an animal whose habits had been described, but which had never before been examined by eastern zoologists. It was remarkably fleet, the descriptions had said. It was rather like a deer, but smaller. It was buff-colored, with a white rump patch. It was inordinately curious. It roamed the West in millions. The animal was the pronghorn, or pronghorn antelope—which is really not an antelope at all. It is the only living representative of the Antilocapridae, the fossil forms of which indicate that it has ranged widely west of the Mississippi since late in the Tertiary period.

The Antilocapridae probably had the same ancestors as the Bovidae, which include our familiar cattle, tl
bison, eland, yak, African antelop
and similar species—all of whic
evolved in the Old World.

In pioneer days, an estimate
twenty to forty million pronghorn
ranged the western grassland fro
Mexico to Canada. By 1907 on
about seventeen thousand remaine
Extensive hunting, the inroads of ci
lization, and overgrazing gradual

Biologists observe doe's movements, *above*, showing location of her fawns.



Rosettes of white rump hair, *right*, act as signals of alarm for pronghorn herd.

ative animal

nghorns will continue to roam the West

them to wooded areas for pro- and forage. But now the herd wing on some 900,000 square in the West. and special pro- to save and strengthen the herd been set up throughout the including about 8,000 square in Arizona, where the photo- s on these pages were taken.

se swiftest of all North Ameri- quadrupeds are smaller than most deer. The cinnamon-buff bodies and white bellies, and the sharply contrasting black and white faces vary in color with the seasons. Hair-shedding is continuous. and the coat is of true hair, containing large air cells that protect from both heat and cold. This is of vital importance to the pronghorn, whose range temperatures in Arizona alone vary from twenty-eight degrees below zero to

YOUNG BUCK's horns are about an inch long, barely showing above hair tufts.

one hundred or more degrees above.

The animal's name is derived from the extension, or prong, on the cattlelike horns of both sexes. The horns are shed in late October and early November and, after shedding, the bony cores—often mistaken for horns—remain. A new, hairlike sheath grows over the old core, lengthening at the tip of the core and broadening toward the base. Until July, when it has hardened and is in its prime, this sheath will fall off if hit a sharp blow.

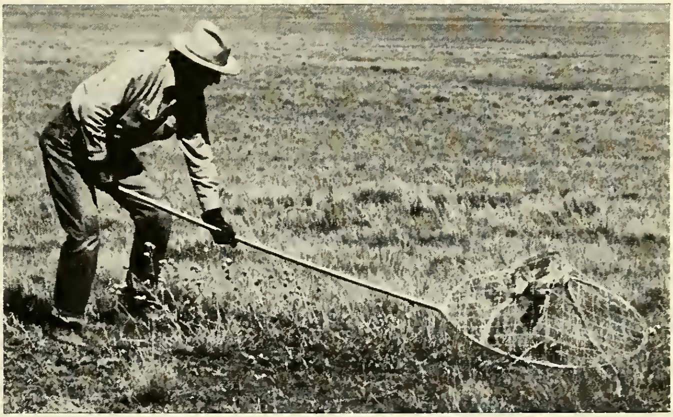
THE pronghorn's eyes are remarkably large in proportion to its head and give it a broad field of vision. This, together with the animal's speed, is its principal method of protection. The pronghorn is magnificent in motion. It is gaited—it walks, trots, leaps, gallops, and lopes. Perhaps it is most striking at high speeds. Bucks run with their noses pointed slightly toward the ground, while the does hold their heads a bit higher—a distinction that aids in field identification. When a herd is running, the does are in the lead, and the bucks protectively bring up the rear. Although they have some trouble in hurdling high obstacles, they will not break their gait on ordinary rocky
terrain. They are equipped with q
large windpipes and lungs, wh
provide extra oxygen for exertion
speed, and they race with th
mouths open for the greatest poss
intake of breath. Their fastest
longed rate of speed has been pla
at about thirty-eight miles an ho
although there have been claims
they can run fifty miles an hour
spurts. On migrations, or when t
are being hunted, it is not unusual
them to travel twenty miles a

DR. SWANK, the Assistant Director of Arizona's Fish and Game Department, works on herd management problems.

On the pronghorn's rump is
patch of pure white hair. When
creature is frightened, these ha
stand erect, and are warning sig
to sharp-eyed herd mates. Often,
stead of running from the cause o

NEWBORN TWINS (not unusual among pronghorns) lie flat on the ground, becoming nearly invisible against surrounding vegetation. While wobbly on their legs the first day, t
can outstrip most pursuers by the time they are a week

Taggers near fawn, which can just be seen in grass ahead of them. Coloration and immobility are a fawn's protection during the first several days of its life.



Hoops and handles of nets are made of aluminum, and net is about three feet in diameter. Here, one terrified fawn attempts to run when it feels the mesh.

the pronghorn will circle it,
hairs erect, and apparently at-
to make itself as visible as pos-
At the first start of this
ver, others of the herd begin
frantically in various direc-
apparently in a panic. There is
to believe, however, that the
erformance serves the purpose
fusing predators.

: of the greatest charms of the
ronghorn lies in its curiosity.
ttracted, sometimes fatally, by
ng that moves. It inspects
blowing in the wind, little
evils, men, and, it is said, even
nery. It will investigate goats,
or dogs, all with the same
l restlessness.

restlessness carries over into
habits. The pronghorn sleeps
ntly both day and night, but
or short periods at a time. Even
it appears to be asleep, it will
quickly to a strange scent, leap-
its feet and bounding away. Its
g habits, too, mirror its quick-
behavior. Pronghorns browse
aze on a large variety of plants,
g quickly from one to another
rts of activity. Actually, this
ng inability to decide on its fa-
food aids in supplying the ani-
ith a balanced diet. It eats bell
sourdock, various weeds and
with impartiality. If it can get
ivated crops, it takes advantage
opportunity. This eclecticism
that no single plant need be
ant to provide the pronghorn
good pasturage. In some parts
range there is only one plant
per square yard, but the animal adjusts easily to the available supply.

Pronghorns are gregarious. The herds live together in harmony during the major portion of the year. In August, however, the bucks begin to show a certain restlessness beyond normal behavior patterns. Rump patches appear whiter, with each hair standing erect. The mane hairs also bristle occasionally. The bucks strike odd poses, dance skittishly, as if they were side-stepping snakes, and have even been described as looking "melancholy." When one buck begins to skip, the others stand watching as if with absorbed interest. This behavior is a prelude to harem-collecting.

Most pronghorns breed when they are something over a year old. When

Great-eyed fawn, once netted, seems only curious as it gazes through mesh.

Fawn weighs five or six pounds when born, gains rapidly during first week.

the kids are dropped, eight months later, the does go apart from the herd. The most favored spot is a slight declivity surrounded by low mounds or hillocks covered with vegetation a foot or so high. Such a location provides both protection and camouflage.

FOLLOWING delivery, the doe cleans the great-eyed fawn (or fawns—twins are not unusual), leaves it lying in the grass and moves away—sometimes as far as half a mile, only returning at regular intervals for the purpose of nursing her young.

A hiding pronghorn fawn blends perfectly with its background. Although it is not camouflaged with spots as are young deer and elk, its waved and dimpled hair serves the same purpose in deflecting light and breaking up the animal's configuration. Its ears are flattened against its head, while its neck and legs are stretched straight out to present as low a silhouette as possible.

Fawns can run awkwardly on the second day. By the third, they become hard to catch, and on the fourth day can outstrip a running man. They still move awkwardly, however, and the smooth stride does not manifest itself until the sixth day. By this time they have begun to show an interest in surrounding vegetation, although they only nibble at it sporadically for their first month of life.

It is at the earliest stage of the fawn's development that the Arizona Game and Fish Department's pronghorn program goes into action. A number of two-man teams, equipped with binoculars, ride over the range in pickup trucks, watching the behavior of the does. If the female has a fawn hidden in the grass, her invariable first reaction is to look hastily in its direction. If the fawn is in no immediate danger, she quickly looks back at the oncoming vehicle. It is imperative that the tagging crews catch that one apprehensive glance toward the fawn if they are to save themselves hours of search. By lining up reference points with their scopes, the taggers can stalk the quarry from long distances and pinpoint them with surprising accuracy.

AT FIRST the tagging operations, which began in 1953 in the Anderson Mesa country—about thirty-five miles southeast of Flagstaff—and have since included other areas, hit a number of snags. Foremost among these was the ability of fawns older than four days to outdistance the men pursuing them. Now taggers use a net on the end of a ten-foot pole. One man distracts the fawn from the front, while the second man creeps up and nets it from behind. Twins continue to present a problem. A fawn will bleat piteously when the net goes over its head, and the alarmed twin takes to its heels.

Once a fawn is safely in the net, it is weighed, tooth eruptions are examined, sex is noted, and the site of the catch is plotted on a map. Then a cattle tag is affixed to the upper part of one ear—a painless procedure, apparently—and the fawn is released. Throughout the operation, the men wear rubber gloves, as too concentrated a human scent might cause the doe to abandon her young.

When released, fawns exhibit different behavior patterns. Some of the older ones leap away and run. Others lie motionless in the position they have been put in by the crew. Young ones often show a trait frequently found in newborn animals: they follow the biologists, and it is virtually impossible to get them to remain at the site where they were tagged.

KNOWLEDGE gained through this pronghorn program is manifold. Herd movement can be observed: dispersal from the fawning grounds and any homing tendency can be followed.

Tagging such animals of a known age and then releasing them into a herd has given biologists a tool to determine the aging of all herd individuals. For instance, aging tables
devised by correlating the mola
of tagged animals taken by h
against that of non-tagged anir

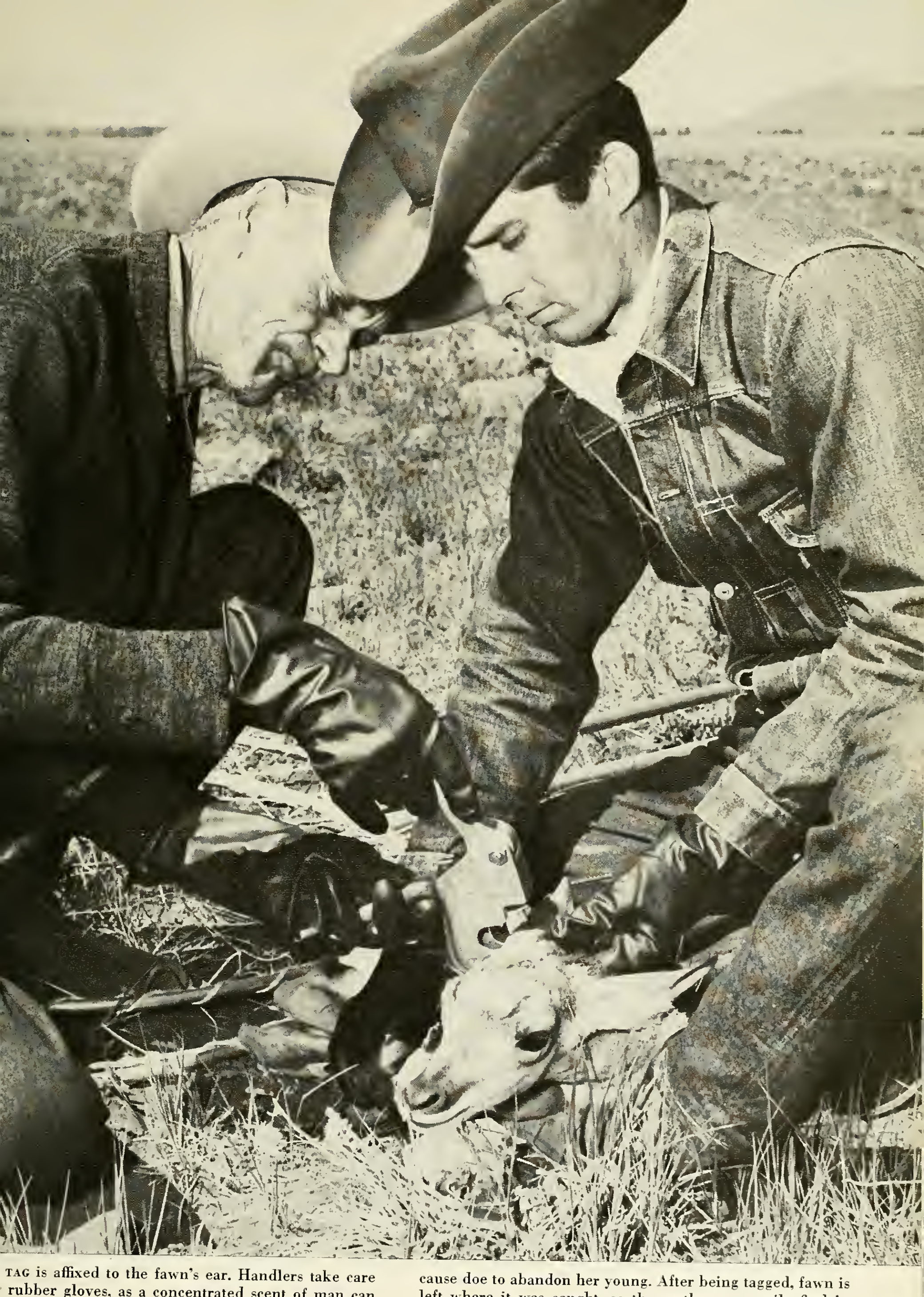
The productivity of a wild
measured in the number of ye
in ratio to the number of adu
mals in the herd—is the most r
indication of the success of
management. If a high proport
the pronghorn population, exc
fawns, is made up of yearlings
agement is good. Too many
animals, however, indicate th
ductivity has slowed—perhaps
infertility or to high fawn morta
either case, such a composition
that remedial measures are imp
to bring the herd into balance.

In this same connection, the
which does breed has importan
agement implications, and can
termined from tagged anim
herd has much greater produ
if the animals breed as ye
rather than in their second ye

PROBABLY the life span
pronghorn is relatively sho
thur Einarsen, in his book *The*
horn Antelope, suggests that i
the neighborhood of eight
Predators account for a num
animals each year. Most dan
perhaps, are coyotes, which
tack any age group. Coyote
tion, however, is most danger
the pronghorn fawn during th
few weeks of its life. When
move in on the young, does wi
attack viciously with their fro
Then, frequently, the doe a
panic-stricken and runs away.
are also often killed by sharp
from pointed hoofs. Fawns are
times endangered, too, by
eagles, and ravens have been
to attack their eyes. Bobcats
tack even a full-grown buck, b
haps the biggest predation da
the herd today lies in the fast-
automobiles on western highw

Storms, too, inevitably tak
toll, perhaps more so today t
the times before cattle and
usurped the lowlands that se
wintering quarters for prongh

At an estimate, there are no
than 100,000 pronghorns r
the West. While the herds wil
again number into the million
programs as that being carrie
Arizona will at least insure t
tinued existence of this uniq
handsome native American m



TAG is affixed to the fawn's ear. Handlers take care rubber gloves, as a concentrated scent of man can cause doe to abandon her young. After being tagged, fawn is left where it was caught, so the mother can easily find it.

Egrets, having bridged the Atlantic, are now established in the Americas.

Success Stor

The cattle egret's explosive spread in t

By Andrew J. Meyerriecks

For many reasons, man has introduced all sorts of animals to new lands far distant from their native homes. Some of these introductions have proved beneficial—the ladybird beetle in the United States, for example—while others have become serious pests like the mongoose in the islands of the Caribbean. But *natural* colonization of new areas and new habitats is a fundamental part of the history of any successful species, including our own. Such natural extensions of the range are not everyday occurrences, however, and today's biologists have been able to study these events in only a few species. When such an opportunity presents itself, the biologist should certainly seize it quickly and with delight.

Just such an opportunity now exists in our own backyards or, more properly, in our own back pastures, in the form of a small white heron. The cattle egret, *Bubulcus ibis*, a species widely distributed in the Old World, has recently gone far beyond the stage of minor increments in range expansion. This bird has bridged the Atlantic and now has an entire new hemisphere at its command—an evolutionary prospect full of potentials both for bird and bird watcher.

We cannot state with certainty when and where the pioneer cattle egret population landed, how they crossed the Alantic, or how many made up the original nucleus or nuclei. But we are sure of several facts. First, South America was the area of original invasion into the New World. Perhaps the earliest written records of the bird's presence were made by a Surinam collector between 1877 and 1882. Second, cattle egrets have spread from that initial "beachhead" to much of northern South America, to many islands in the Caribbean, and through a great area in the eastern United States. Finally, large numbers of cattle egrets are now breeding in many places on both continents. With every passing year, new distributional data, new breeding sites, and other new facts are being recorded about the New World's most exciting heron.

In 1959, I had an opportunity to study the cattle egrets in Florida, where the bird is now a common roadside sight. I began field work in the Florida Keys, the long chain of mangrove-covered islands that extends southwestward from the tip of peninsular Florida. Little is known about the migratory habits of these birds, but it is obvious that they use the Keys to enter the mainland from some unknown region to the south.

Cattle egrets typically move about in flocks, small or large, and this social behavior was evident in the migrating groups I saw in the Keys. Such behavior is, itself, a mechanism favoring overseas dispersal. It was probably as a small flock that the birds first crossed the Atlantic. On February 19, for example, I saw a flock of three cattle egrets on Greyhound Key; on February 20, a flock of nine on Plantation Key; on February 21, flocks of two, ten, seventeen, ten, and thirty from Crawl Key to Lower Matecumbe Key. On these and other dates, I noted that the flocks fed from a few minutes to se hours in grassy areas bordering Route 1, the main road througl Keys. Then, without exception these flocks took off and flew northeast toward the mainlan Florida. Were they coming Cuba, Quintana Roo, or Yuca We don't know.

Some populations of these winter in southern Florida, and fact may account for the six egrets I saw on Payne's Prairie, Gainesville, on February 11, o week before I noted migratory in the Keys. Furthermore, cattle e were courting and building ne Greynold's Park, North Miami B on February 18, the day before the first migrants to the south These birds may have come populations wintering in Fl but where were the migrants ing from? What regular migr routes, if any, are they using? are a few of the many question still await answers.

Cattle egrets do not breed i Florida Keys, so after my r naissance there I headed towar birds' stronghold in the Lake chobee area. Despite heavy, co ous rains I was able to make de observations on the birds' fascin feeding behavior. As its co name suggests, this species reg associates with cattle, and the ciation is of definite advanta the bird. While grazing cattle slowly over their pasture land, e accompanied by one or, more cally, two egrets, which station selves alongside the heads o lumbering beasts. The pasture in stirred up by the movements o cattle, are seized and eaten b watchful egrets. In effect, the act as unwitting beaters for the

Is this relationship one-sided? point is in dispute. Cattle are infested with ticks, and stomach

---

Dr. Meyerriecks is a specialist in heron research, and also works with the Massachusetts Audubon Society.

f a Pioneering Bird

w World provides a matchless chance for biological studies

Typical position for egret is at the head of grazing cattle. Insects stirred up by animal's movement are eaten by birds.

ANY HOOFED ANIMAL is followed by the egrets. In the Old World, the birds' associates include elephants, rhinos, zebras, antelope, and, often, buffalo.

yses show that cattle egrets do ticks. If the egrets picked these t from the hides of the cattle, we w have a classic example of symbi —the egrets help the cattle by rer ing and eating parasites, while cattle stir up food for the birds. ' would be a neat demonstration, we have no proof of it! It is true the birds eat ticks—indeed, in s parts of the world they are called herons—but apparently they them up from the ground. Furt more, these ticks make up on minor part of the egrets' diet.

SYMBIOSIS can involve more one relationship between spe however. It may be true, for ex ple, that the always alert egrets their hoofed partners of pote enemies. A similar relationship ists between the ostrich, and w beests and zebras. The bird feed insects flushed by the animals, an head, high above the tall grass, as a periscope. Any sign of frigh the part of the bird immediately s the mammals running for safety. egrets are conspicuously white. tive, and highly social: their den flights and warning calls c scarcely go unnoticed by the c

TRUE SYMBIOTIC RELATIONSHIP, in which birds eat ticks on cattle's hide and the cattle stir up insects for the birds, has not been established in the case of egrets. Although eat some ticks, they form only a minor part of their

ossible service may have value
case of the egrets' mammalian
ates in Africa—antelope, ze-
rhinos, elephants, and the like.
ver, with respect to domestic
the service seems valueless. A
-in herd, destined for the
terhouse, would benefit little
any agitation of the egrets.
heless, in the original, wild sit-
, such a relationship would
both bird and herd.
nost situations, I believe, this
ition is a one-sided affair—the
are opportunistic, following
ver beast will beat for them.
e the birds obliged to associate
ively with cattle. Around Lake
iobee, I saw cattle egrets also
ing horses, sheep, goats, and
while in other parts of the
the egrets follow many other
of mammals.

v one non-mammalian species
as a beater for the egrets—an
ation that has not been previ-
recorded. Around Lake Okee-
, the Florida crane tends to
in wet, marshy areas—terrain
rticularly to the liking of the
egrets. On several occasions,
r, when the cranes moved onto

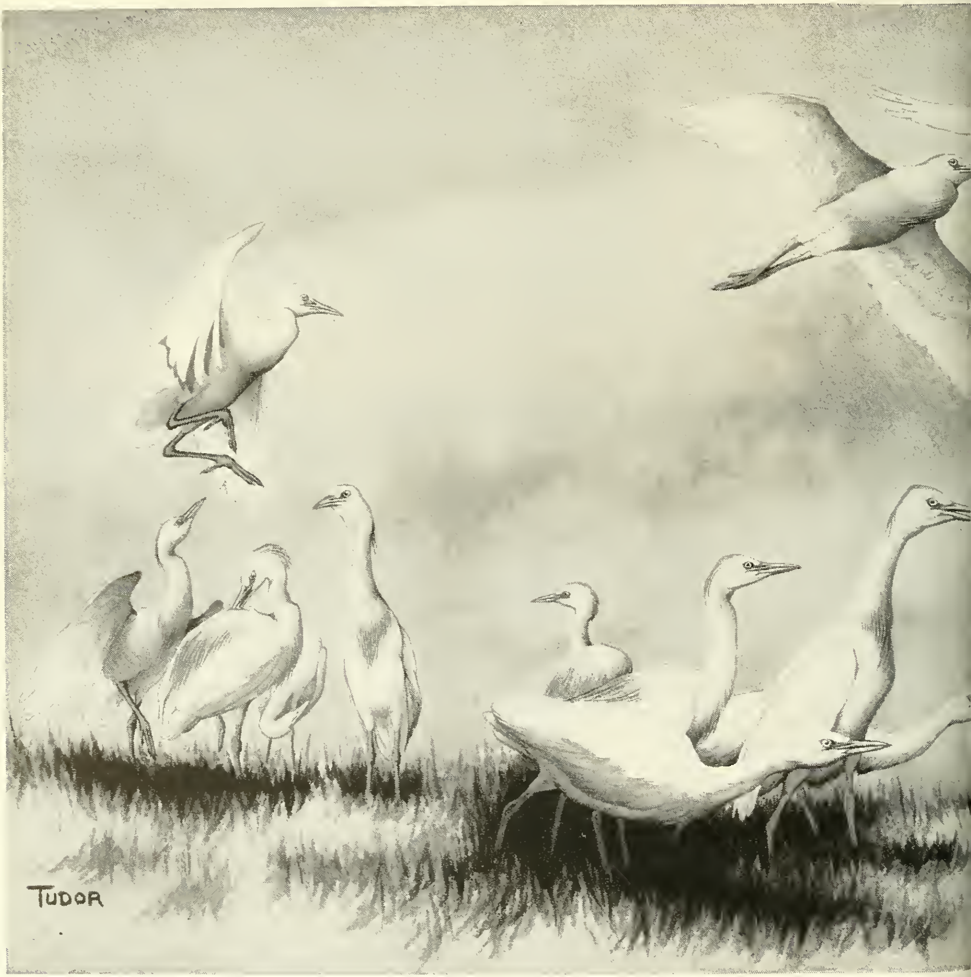
SHEEP can also be feeding associates of egrets, although birds can and do feed alone. Occasionally they will perch on fence posts and snatch flying insects.

FUL BIRD not only takes advantage of food stirred
og, *above;* when feeding near shallow ponds it may vary its diet by eating small fish, which bird catches in a manner typical of the many herons to which it is related.

drier ground, I saw flocks of up to 150 egrets land near the cranes and begin to follow them. Here was an interesting example of competition. Both the cranes and the egrets were after the same prey—insects (mainly grasshoppers)—but the egrets were letting the cranes do most of the work. This association with another bird, feeding on the same prey in the same area, was successful. I saw the egrets make innumerable kills. By artful dodging, the smaller species was able to take advantage of the larger birds' bulk in scaring up food enough for both of them.

Whenever the egrets got too close to a feeding crane, the larger bird would threaten the smaller species briefly and drive it away. A simple turning of the crane's head was usually sufficient but, if this did not deter the egret, the crane would lower its head and make a short strike. This thrust always worked.

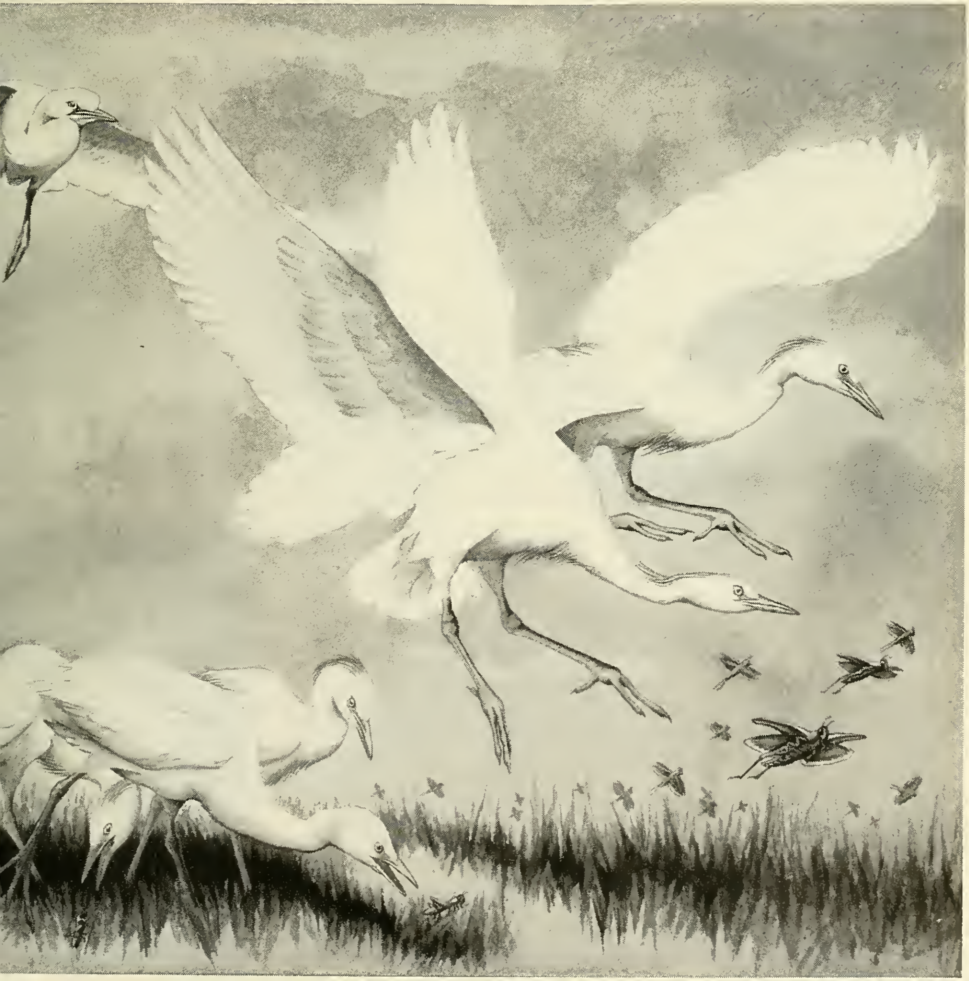
ARE cattle egrets obliged to follow other animals in order to get a daily ration? Although this predilection for hoofed and other associates is typical of the egrets' feeding behavior, they can and do feed by themselves. The migratory flo
observed in the Keys fed alo
grassy areas a few feet from the
Around Lake Okeechobee on
occasions, I saw single birds, a
as small to large flocks, feedi
pastures when no cattle or
large animals were in sight. S
times an egret would perch on a
post in a field or on the roof
chicken coop and snatch flyir
sects. I have also often seen
egrets, perched on the backs of
snapping up flies that buzzed a
the resting cows. True, the flies
undoubtedly attracted to the



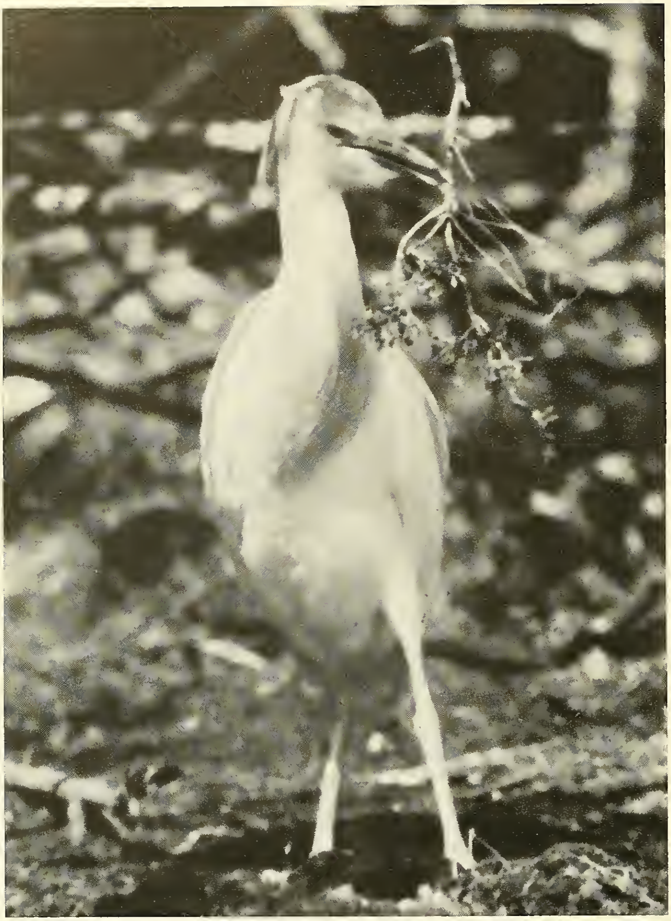
"LEAPFROG" FEEDING is an unusual behavior pattern of the egrets. A flock of birds land in field and one or two make short runs forward to seize grasshoppers, thus stirri
other insects. Bird at back of flock then flies up,

e latter's role in helping the
was passive. Twice I saw single
wade in shallow ponds and
mall fish in typical heron man-
ut the most fascinating feeding
or I observed among the cattle
in Florida is what I call "leap-
feeding (illustration, *below*).

RE is a typical observation: a
lozen egrets land in an empty
e. At first the birds content
lves with looking about, or
g for position in the flock, or
ng a few flight feathers. Then
two birds at the edge of the
group begin to peer carefully at the stubble, stretching and weaving their slender necks back and forth. One makes a short, chicken-like run forward and snaps up a grasshopper. This commotion stirs a few insects to flight. A second egret in the rather compact flock runs toward the food source and stirs a few more insects from the grass. Now the flock begins to mill about; a bird from the rear flies up and over the flock, landing just in front of the foraging egrets. As it lands, it seizes an insect disturbed by its flight actions. Two more egrets fly up from the standing group, over the feeding birds, and land in front of them. They begin to peer, to weave, to strike at their prey. The remaining birds in the flock now fly up en masse and leap over the backs of their actively feeding flock partners. By this time, the bird or birds that began to forage first are at the rear of the feeding group. As their food supply is temporarily exhausted or has escaped, they now leap over the feeding egrets, to land at the front of the group and stir up new prey as they alight. In this way, the members of the flock, working as a team, make their way across the field, each taking his turn



**t of the foraging egrets and catches an insect. Other
om rear follow, and presently remainder "leap" over
backs of fellows, leaving original beaters in rear. Thus, each in turn takes its place as beater, forager, and feeder.**



Establishment of territory by male begins courtship. Before finding mate, male starts to build the nest, often breaking fresh twigs for the purpose.

as beater, then forager, then feeder and, finally—by "leapfrogging"—as beater once more.

The scene is not always played in an empty pasture. I have watched the birds following cattle in the usual manner until a light rain began to fall; then the cattle stopped grazing or even took shelter. The egrets would huddle in one group, hunched over, with necks withdrawn and feathers fluffed out. One or more birds at the edge of the flock would start to forage and, in a matter of a few minutes, the entire group would be "leapfrog" feeding in the rain while their former animal associates contentedly chewed their cuds and rested in the shelter of a nearby pine grove.

The pattern of following other animals, however, serves cattle egrets admirably. They occupy a niche—that is, they play a specific role in the community of living things—without serious competition. True, snowy egrets and a few other heron species follow cattle and other animals for the same purpose, but the cattle egrets ply their selected trade masterfully. What will happen when, inevitably, the birds reach the Great Plains of North America and the vast pampas of South America? Biologists should and must be there, watching them, when they do. The great herds of domestic cattle in these areas are ripe for exploitation by cattle egrets.

What form, we may wonder, wil
impending exploitation take?

Leaving the Okeechobee coun
headed north for Lake Alic
the University of Florida camp
Gainesville. This was my last c
to see the courtship of the spec
part of their general biology t
completely unknown. Lake Alic
tually a freshwater swamp, is
dise for a heron enthusiast. Bre
there in 1959 were white and
ibises, anhingas, Florida and p
gallinules, Louisiana and little
herons, snowy egrets, and, f
nately, cattle egrets. All of the
were nesting in the same colony,
in red maples, willows, and b
bushes, no one of which cont
more than three cattle egret
However, there are records of
dreds of their nests being found
together in a single tree.

I took a comfortable, fully ex
station on a rise at the edge
breeding colony, and was able
the courtship of the cattle egret
the start. It had been raining ha
several weeks before my arri
Lake Alice, and it was still r
when I started my observation
that first day, all of the egrets le
nesting area, which they had
using as a roost, and foraged d
the day on Payne's Prairie, a n
wet prairie and marsh area
mainly as a cattle pasture. T
dusk, the egrets began to trickle
to their roosts in small flocks

Display gestures on his territo
interrupted by male, preening fe

morning. however, the rains ed, the sky was bright and clear, he nesting area was alive with ng herons and egrets.

o things stood out as indicators e start of the egrets' breeding ior. First, many of them red in the nesting area and did rage at all during the day. Secll the birds that stayed showed kable changes in the color of soft parts—bill, lores, orbital egs, and feet. During the nonng season, cattle egrets have ellow or pale orange bills; the tion of the lores and orbital s variable, but typically fleshd or dull yellowish-green; the nd feet tend to be dull yellowith the rear part of the legs hat blackish, as are the toes. umage of non-breeding birds is with a very pale, buffy wash on wn, lower throat, and back. On st day of frenzied activity, howhe cattle egrets at Lake Alice d a very different complexion.

bills of most were a brilliant by, with a contrasting, bright tip (I immediately thought of attern of Halloween candy Some birds, however, had bills ere scarlet or ruby throughout. had scarlet lores and orbital hile others had these areas coluby or magenta. The legs and re either dark magenta or dark here was great variation in the f the iris: typically straw yellow in non-breeding birds, it now ranged from pink to ruby. All had conspicuous, buff-colored plumes on the crown, lower throat, and back. In short. the cow-followers had lost their plain appearance and were now resplendent in nuptial dress.

LUMAGE is more lustrous during ip than at other times of year.

AGGRESSIVE MALE keeps a female from territory, and if she remains, becomes more hostile. This behavior continues for several days, until the birds court.

Although all were bright, some of the egrets seemed duller than others. The more lustrous ones soon proved to be males. These were highly agitated, moving restlessly about the branches of a tree, making short flights to nearby trees and, more significantly, threatening, chasing, and fighting any other cattle egrets that came too close. This random behavior, however, quickly became localized in one small section of the nesting area: the males had started to establish and defend a territory.

THE initial size of this area varied from male to male but, in general, it consisted of a space roughly circular in shape, with a radius of about five yards. The center of the circle was the most important part of the male's territory—his display post. From this spot, the male began to advertise his presence in the nesting area by performing a series of vigorously executed displays.

The most common gesture used at the start is what I call the "Snap Display." The male, perched on a branch, suddenly extends his head and neck fully out and down, clicks

Egrets nest in colonies, often with such other birds as ibises, gallinules, herons, and snowy egrets, and there are records of hundreds of cattle egret nests being found single tree. Here a bird is adjusting one of its four

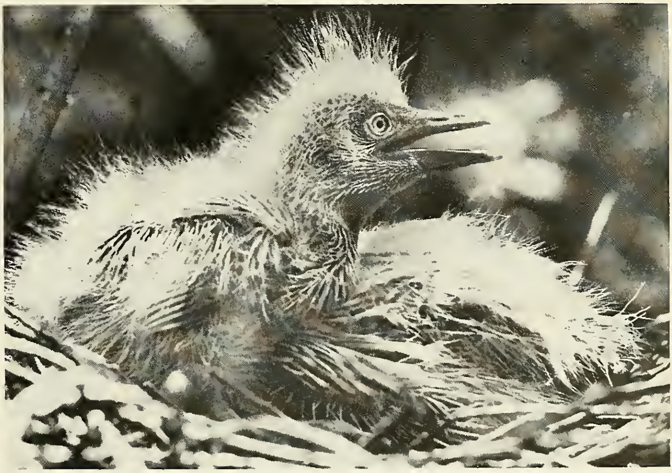
his mandibles together, retracts his head and neck to the normal posture for a moment, then extends them fully—either horizontally or slightly upward. Then he seizes a twig and wrestles with it a moment or two before reverting to the normal perched posture. Males that are "snapping" are approached quickly by one or more females, but at this stage the females are forced to leave the male's territory by his aggressive posturing.

The male crouches low at the approach of a female, then walks stiffly toward her, with crest, neck, and back plumes fully erect. Then the bristling male lashes out at the female with his bill and utters a rasping "kowwh-kowwh." Normally she is quick to retreat: if not, the male drives her from his domain by a direct attack. If a male has temporarily vacated his territory (to gather nest twigs, for example) and finds a female there on his return, he forces her to withdraw by using threat displays of the same or a similar nature. If the intruder is a rival male, the territory owner undertakes the same displays he uses to intimidate females. Males, however, tend only to threaten females, while they will attack other males.

On the first or second day of territorial advertising, the males showed their first "Stretch Displays." From a standing position on or near the partly built nest, the male suddenly bends forward to a low crouch, at the same time rapidly moving his legs up and down in a dancing tion. He then quickly loops his slightly out and down, points his straight up, moves his tightly cu neck down in one vigorous pump, then proceeds to swing his vertic aligned bill and neck in a circula elliptical path. The male may ro his head and neck from one to times; during the swaying part of display, he usually erects his c breast, and back plumes. During display, one or more females come to watch the male's perfo ance. They are stimulated to next to him, but again he repulses such attempts. I noted, however, such hostility on the part of the was much less intense after a Stre Display than after a Snap Disp

OF NESTING AREAS indicates the success of the bird
ting to a range in which it was unknown only a few years ago. Unkempt appearance of the egret above is owing to its fluffing out feathers that have been dampened by rain.

her heron species that I have
d, this period of male display,
approach, and threatening
asing by the male may go on
veek or more, with a gradual
nce in male aggressiveness.
for the cattle egret—on the
or third day, the female has
ough and forces the issue by
; squarely next to the male in
tly built nest. A particularly
ive male may still succeed in
the brash female away, but
ales submit. Then the pair en-
billing, feather-nibbling, and
ilding—with the male acting
ily as gatherer while the fe-
oes most of the building. A
ather quiet betrothal period is
d by copulation—which usu-



YOUNG EGRETS are brooded and fed by both parents. Although specialists in their feeding behavior, cattle egrets nest in a manner typical of all herons.

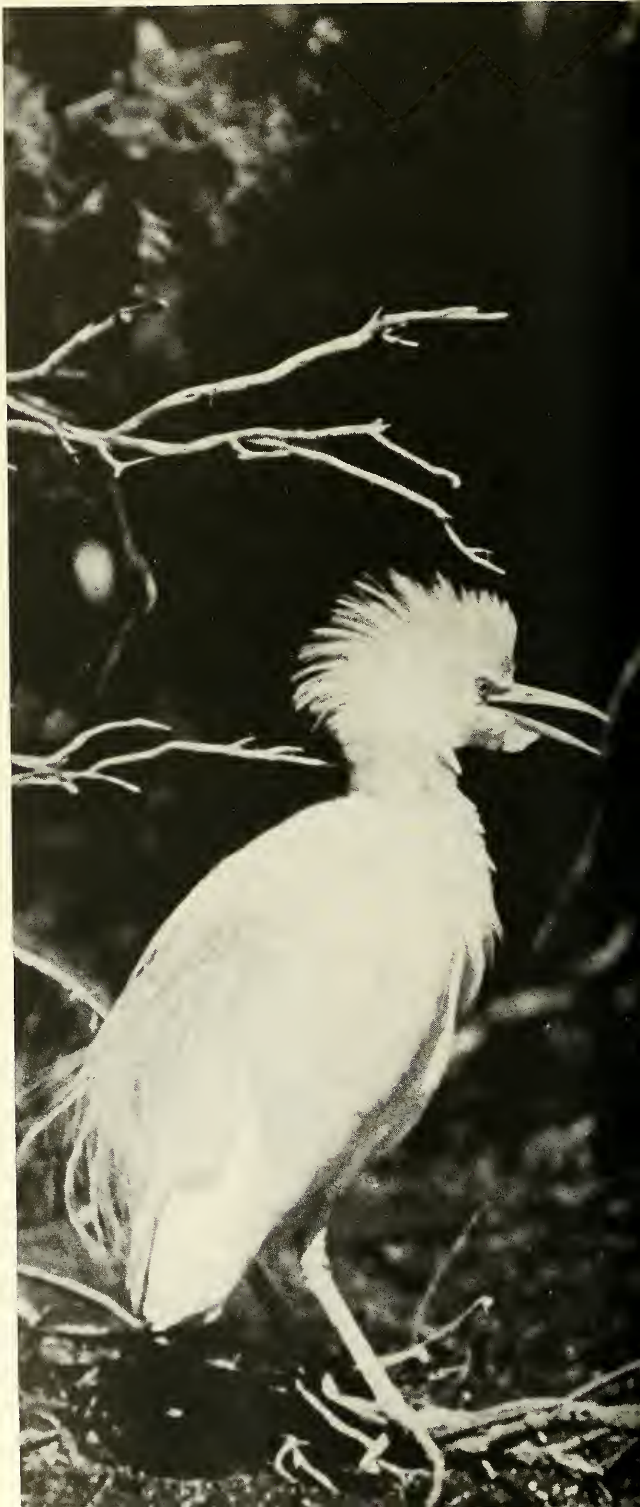
ally takes place on the nest or a few feet from it—and egg-laying. The pair then enters the uneventful, parental part of the nesting cycle.

I LEFT Lake Alice when most of the cattle egrets were sitting quietly on their eggs. I was fortunate in all the new information I had been able to gather about these birds, but I also realized how important this species can and should become to biologists in general. Here is an eminently successful animal: it has crossed the Atlantic Ocean on its own, spread throughout an entirely new range, and is now breeding commonly in regions where cattle egrets were unknown only a few years ago.

What is biological success? Invasion of distant lands, rapid range expansion in the new areas, population build-up at a great rate, further spread from established breeding sites—certainly these can be considered attributes of success. What about the cattle egret's peculiar feeding behavior? Surely this is important to the continued welfare of the species, but is it crucial?

North and South America have many other well-established heron species and many of these are expanding their ranges, too. But they are being outstripped in this respect by the newcomer. Why? Will several major supply pools form in the cattle egret's new range, centers of abundance that will feed the outlying districts with new and better adaptive characteristics? When the cattle egrets reach and conquer the Great Plains of North America—where the feeding niche is vacant and waiting throughout a vast range largely cleared by man—will they move south through Mexico, or will they cross the Gulf of Mexico in order to reach a winter habitat?

WE can, of course, make guesses, advance theories, or propose schemes based on a few shreds of evidence. But, more importantly, we are now in a position, if programmed cattle egret observations are undertaken, to make concrete many of our rather vague ideas about biological success.



Erecting plumes on neck, crest, and back, hostile male prepares to defend nesting territory from intrusion by an attracted female who attempts to land.

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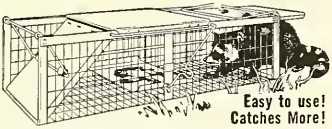

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REVIEWS *(continued from page 7)*

it hard to separate myth from reality, the fanciful from the proved. *Out of Noah's Ark* is good reading, but one persists in the nagging feeling that there is too much of it.

BIRDS OF MARTHA'S VINEYARD, by Ludlow Griscom and Guy Emerson. *Privately printed; sponsored by the Massachusetts Audubon Society, $4.50; 164 pp., illus.*

HERE is an excellent book, a labor of love and intelligence, which will appeal to the amateur as well as the professional. The check list includes 342 species. Some attention is paid to history and topography, and a map is provided.

THE ARMCHAIR SCIENCE READER, edited by Isabel S. Gordon and Sophie Sorkin. *Simon & Schuster, $7.95; 832 pp.*

THERE are many more anthologies of poetry than of science, perhaps because poets are, *ipso facto*, articulate; so this volume may fill a need. In fact, it contains its share of poems, along with specimens of science fiction, philosophy, social history, ancient and modern natural history, anthropology, and a host of related and interrelated fields of knowledge. Its very diversity may be one of its drawbacks. All the same, if you like samples, you may like this book.

THIS LAND OF OURS, by Alice Harvey Hubbard. *Macmillan, $4.95; 272 pp.*

BECAUSE of her experience in garden club work and community improvement campaigns, Alice Harvey Hubbard has written a book on conservation that will be of interest and practical importance to many local planners. She discusses over 150 specific projects, and generally offers a patchwork quilt of information. Much of it will be valuable to workers in this area, whether they are interested in community forests, window boxes to beautify their towns, flower festivals, or 4H projects, or in the larger aspects of soil and water conservation. And it is encouraging to find that so much is being done at the community level.

TUKANI, by Helmut Sick. *Eriksson-Taplinger, $5.00; 240 pp., illus.*

HERE is an account of the Roncador–Xingu expedition into Central Brazil, whose primary purpose was to break open the wilderness and make it "fit for human exploitation." Although the scientists who went along did not find as many surprises in the interior as they had wished for, they were able to get a great deal of new data with respect to natural history. Dr. Sick's book is primarily of interest in its very complete account of the fauna, and to a
lesser extent of the plants, the weath
and the Indians they encountered duri
the expedition's seven years. Merely
list the variety of Brazil's birds, insec
and animals is to indicate what our civ
ization is now trying to encroach upo
When discussed by an eyewitness wi
accuracy, simplicity, and feeling, th
become very real indeed. One suspe
that the translation from the Germ
may be very awkward at times, but t
material is unfailingly interesting.

DESERT PLANTS (CACTI AND SUCC
LENTS), by Oliver and Margaret Lee
W.H. & L. Collingridge, London, 3
net; and Transatlantic Arts, Flori
$7.50; 220 pp., illus.

AS specialists in cacti and succulen
Sir Oliver and Lady Leese a
known throughout the world, and t
international aspect of the book ad
greatly to its interest. End papers sh
the global distribution of cacti and s
culents, and special attention is given
their desert habitats in America and
Africa, where General Leese, as co
mander of the 30th Corps during
North African campaign, first develo
his interest in these plants. Chapters
included on propagation, care, arra
ing a collection, and diseases and pe
There is also a selected list of pla
and a bibliography. The book is writ
in a forthright style, and the autho
enthusiasm shines through. A good b
despite the price, for anyone with e
the slightest interest in the subject.

NO ROOM IN THE ARK, by Alan Moo
head. *Harper, $5.00; 227 pp., illus.*

THE author, who is well known for
historical and biographical writi
(Montgomery, Gallipoli, and *The R*
sian Revolution), has written a sort
travelogue of some recent trips in Afr
—or rather, rewritten, since some
this material first appeared in differ
form in *The New Yorker*. The book
intelligent, alert, and literate; but
theme—the contrast between the secu
life of Africa and the changes
twentieth century is effecting in it
diminished by a rather superficial
generally not very well-informed view
things. However, this does not les
the pleasure the writing can offer, or
interest of many of the vignettes
Moorehead paints.

GEMSTONES OF NORTH AMERICA, by J
Sinkankas. *Van Nostrand, $15.00;*
pp., illus.

THE book *Gemstones of North Am*
ica is by a knowledgeable and ent
siastic amateur and is valuable chiefly
its extensive information on the locali
where gemstones are found. Since thi
a large, expensive, and handsome bo

it seem superfluous to suggest that more color plates would not have miss; but for the layman color is rily of great value in identification. er, this criticism is not intended ract from a book which provides nt historical and descriptive infor-, as well as a great quantity of bout the location of gems.

IDOOR PLANTS, by A.C. Muller-a. *Emerson Books*, $2.95; 114 *pp.*,

100 plants included in this little ide are a good, representative and the photographs that accom-heir description and advice as to are are well chosen. The book ply but accurately written, and be very useful for the tyro who plants in the house or apart-ut needs a professional to help an.

ERS AND FLIGHT, by Clarence J. ler. *Macmillan, $3.95; 214 pp.*,

: is a book for young readers that es not succumb to the temptation ng down or over-simplifying. Ex-ornithological material is pro-n a well-written, substantial text. ions of the physical characteris-birds in general and, more par-y, of the relationship of many an species to their environment irther exploration by the watcher ield or by the student of biology.

ALT WATER AQUARIUM IN THE by Robert P. L. Straughan. *A. S. $7.50; 252 pp., illus.*

E who have long hesitated to start lt water aquarium in the face of gly insurmountable odds will be at reassured by this book. It *can* —but not without painstaking at-and Mr. Straughan, an expe-aquarist and marine collector, the successful marine aquarium o possibility than it used to be. ok is a little expensive, but pro-llustrated.

LEY'S EXOTIC ZOOLOGY, by Willy king, *$4.95; 468 pp., illus.*

word "exotic" is a teaser, bring-to mind the serpents and dragons ich Mr. Ley's book abounds. Ley of an antiquarian than a scien-hough he offers facts as well as he dredges in the muddy waters with a will, while presenting findings at the same time. Moas, ths, animals vegetable, animals and even animals real—a pot-of the amazing and the common. ll makes for strangely unexciting —perhaps because of a wooden rhaps because the problems that

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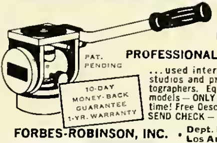

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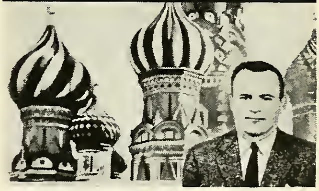

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suggest themselves are not allowed much importance. This is not an original essay or a thoughtful use of the facts, but a random borrowing. The reader is never quite sure as to the author's intentions, and while that may be part of the fun, the book seems to follow a hit-or-miss approach to some challenging material.

Adventurous Alliance, The Story of the Agassiz Family of Boston, by Louise Hall Tharp. *Little, Brown, $5.00; 354 pp., illus.*

Louise Hall Tharp has set out to write a domestic narrative. It is well told, from beginning to end, but if the period is re-created and brought close to contemporary readers, Agassiz himself remains intangible. Not that information is lacking about his life and fortunes: much is said about his personal force and his intellectual influence on American society. But the background is clearer than the man who stands in front of it.

The Care and Cultivation of Indoor Plants, by Violet Stevenson. *Philosophical Library, $4.75; 159 pp., illus.*

A useful, sturdily written little book designed to help the home owner see his favorite potted plants through the year. It gives thorough details as to proper treatment and placement, as well as advice on soil conditions and care of the sick. The photographs, regrettably, are uninspired.

Southwest Gardening, by Rosalie Doolittle, in collaboration with Harriet Tiedebohl. *University of New Mexico Press, $5.00; 222 pp., illus.*

This book won a prize from the National Council of Garden Clubs, and in fact it is well printed and presented. However, the author introduces her subject with an irritating "flowers-as-pets" angle, goes on to assume a frequently fussy authority about the do's and don'ts of the business, and rather neglects the soil and weather conditions of the Southwest, although this is specifically a regional book. But all in all, what can be done with landscaping and gardening under the prevailing con tions is simply explained, and the c ture of individual plants examined some detail. A useful volume for th about to dig in at Tucson or Taos.

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The Story of Earth Science, Horace G. Richards. *Lippincott, $3. 169 pp., illus.*

The author is a geologist whose pressed intention was to write ab earth science not so much for the v young as for the "slightly advanced." is a beginner's book, then, but one wh might be read with profit by an untuto adult. Useful guides are provided for identification of common rocks, foss and minerals, and their general char teristics are clearly and simply describ

Hidden America, by Roland Wells R bins and Evan Jones. *Knopf, $5.00; pp., illus.*

Amateur archeology on a high le Roland Wells Robbins, who written this book in collaboration w Evan Jones, was the discoverer of site of Thoreau's cabin on the shores Walden Pond. He also directed the cavation of the colonial ironworks Saugus, Massachusetts, and has su his probing rods into the soil over ma other historic and prehistoric sites this country. His book is honest and pretentious, makes no unsubstantia claims, and, as with the supposed tra of the Viking occupancy of Cape C retains an intelligent skepticism. T photographs are well chosen.

Science in Progress, Eleventh Ser edited by Hugh Taylor. *Yale Univers Press, $7.50; 379 pp.*

The latest in a very excellent seri whose contributions are based on Sigma Xi lectures for 1957 and 1958. particular note in the present b are chapters on mountain building, Armand J. Eardley; continental grow by J. Tuzo Wilson; cosmic radiation, Serge A. Korff; smoking and de rates, by E. Cuyler Hammond; a viruses and cancer, by J. W. Beard.

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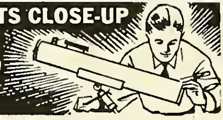

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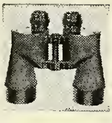

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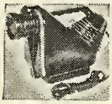

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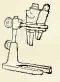

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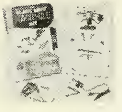

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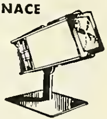

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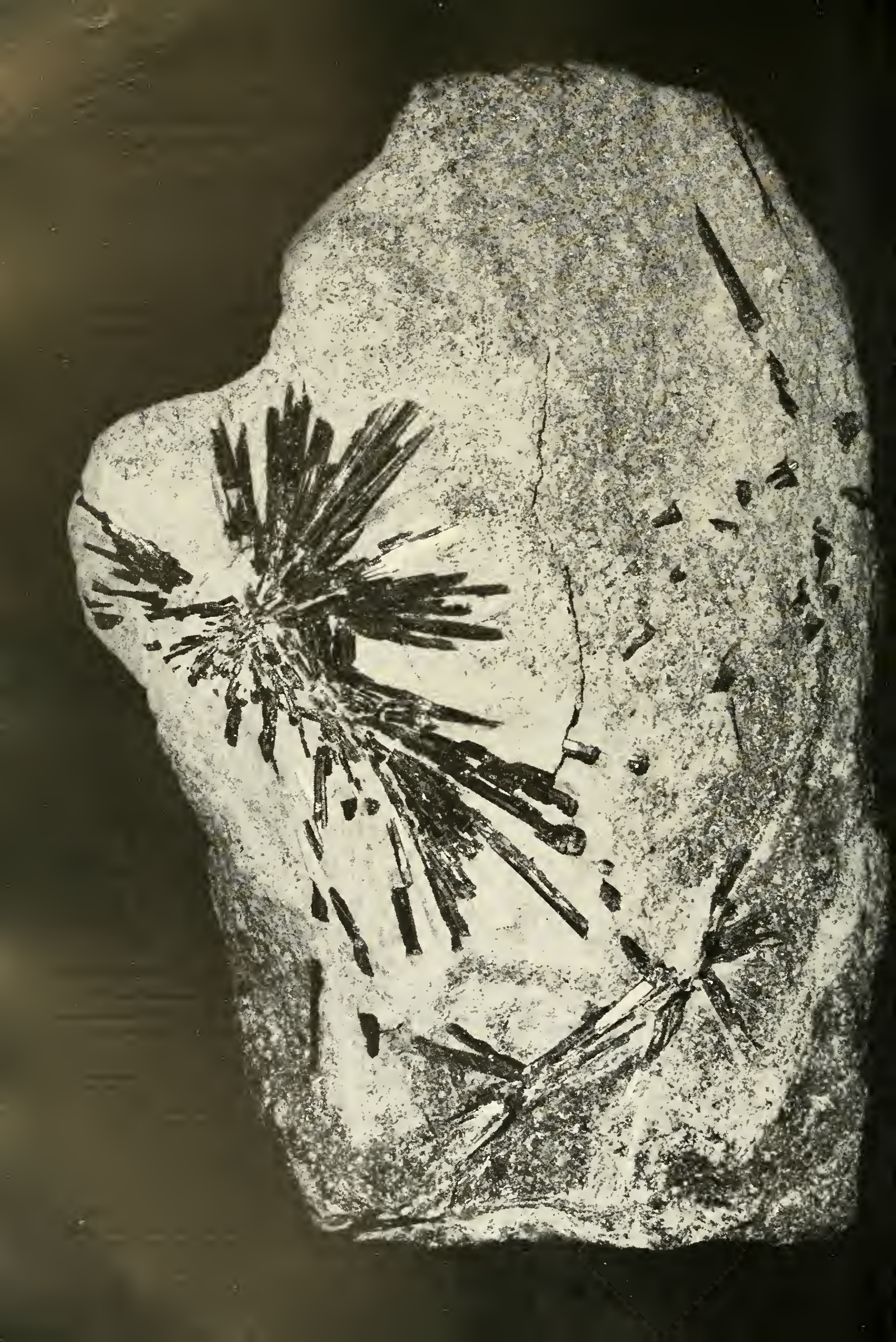

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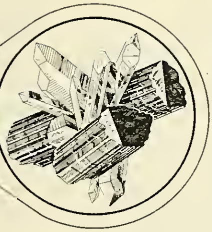


By Paul Mason Tilden

two hundred and sixty years ago. ;roup of traders from the island lon arrived in Holland, bringing other merchandise a small hoard wnish, semiprecious gemstones. the traders called *toramalli*—not cularly significant word mineral- y, since Singhalese traders of the sed the same word in referring umber of other precious stones n Ceylon's gem-rich gravels.

e particular *toramalli* were neither r apparently of much interest to tch gem-cutters, who had mar- . similar mineral from Brazil—in ent and much more salable color rly as the seventeenth century he name of "Brazilian emerald." exciting brown stones were tossed s playthings for the local street , so it was said; but these Singha- iders, nameless in history, left eir unwanted stones a name for the most remarkable of the two- id-odd minerals that, in greater r amount, constitute the crust of th. From the *toramalli* of Ceylon, of the eighteenth-century English n" and the later "tourmalin," ur modern word "tourmaline," a or a mineral that is both a delight ollector and, in certain of its pecu- , a challenge to the mineralogist.

LAR field guides and handbooks ninerals describe tourmaline as iplex silicate," or a "complex f silicate compounds." Such de- ns have both the merit of being e and being conservative of paper esetter's time—a fuller account of mical and physical complexities mineral would burden a simple iide with an intolerable number :s. Indeed, tourmaline has been ely characterized as "the trash of the world of minerals." After all the other minerals were allotted their quotas of elements, say the mineralogists with tongue in cheek, tourmaline received what was left over. At least twenty-one of the eighty-eight natural elements have been positively identified in analyses of this mineral.

TOURMALINE is essentially a borosilicate of the metal aluminum, containing also the elements sodium, magnesium, and hydrogen. The structure of the mineral, however, seems to allow to a remarkable degree the substitution of one element for another within its atomic framework. This characteristic, as might be imagined, is subject to certain limitations. Human feet may be shod with shoes of many different colors and styles, provided that the shoes fit the feet. Similarly, the elements, or groups of elements, that can make substitutions in the composition of tourmaline must "fit" the mineral's basic structure. It is such elemental substitutions that give rise to the several distinct series—and innumerable varieties within the series—that make tourmaline such an attractive item for the mineral collector.

For example, the presence of a substantial amount of iron produces the coal-black tourmaline commonly known as "schorl." Where magnesium is the replacing element, the mineral occurs as the brown or greenish-brown "dravite," commonly found in metamorphosed limestones. The presence of relatively large amounts of the light, alkali metal lithium, either with or without its usual companion, cesium, gives rise to the lithium or "colored" tourmaline, the eccentricities of which have been the subject of much speculation.

The black, iron-rich variety of tourmaline is a rather common mineral wherever granite has eaten or shouldered its way into rocks that are now exposed by erosion, and fine specimens are seldom missing from the most rudimentary mineral collections. In its massive form, black tourmaline has a superficial resemblance to anthracite coal—and apparently was mistaken for that substance by more than one of the earlier settlers of this country. Charles T. Jackson, American geologist, doctor of medicine, and agricultural reformer of an earlier day, noted in 1844 that tourmaline "... abounds in the primary rocks, and is sometimes mistaken for coal, on account of its apparent resemblance to anthracite." The Doctor dryly added, however, that "... the want of combustibility is ... sufficient to distinguish it from that substance."

In using the term "primary," Dr. Jackson was referring to rocks like the granites and gneisses, at that time thought to be the original stuff of the earth's crust. While this term has long since disappeared from the language of geology, it is in granite, especially, that the mineral tourmaline "abounds" and reaches both its perfection of form and its greatest crystal size. Granitic intrusions that exhibit the coarsely crystallized, dikelike or pod-shaped bodies called pegmatites, or "giant granites," may yield crystals of the black variety of tourmaline, the dimensions of which are sometimes measurable in feet.

There is a special class of granitic pegmatite—constituting, perhaps, one per cent of the total—in which, through a complex and not wholly understood process of mineral replacement, there may occur an assemblage of lithium- and phosphorus-bearing minerals. Among these are likely to be such collectibles as spodumene, lepidolite, amblygonite, or petalite—accompanied, perhaps, by cassiterite, columbite, the rare cesium mineral pollucite, and an assortment of lithium, iron, and manganese phosphates such as triphylite, heterosite, vivianite, and a host of others, some of which have yet to be classified and named. It is also this one per cent of pegmatites that furnishes the colorful red, pink, green, and blue tourmalines, and the mineralogically challenging bicolored and multicolored specimens so coveted by collectors and those in the semiprecious gem trade.

COLORATION of lithium—pegmatite tourmalines has been the subject of many investigations. In addition to crystals that are entirely of one color, there are others that may show red at one end and green at the other, or pink, yellow, and green, or pink, colorless, and green, or combinations of these colors, to create as many as four or five different zones along the length of a crystal. The colors may separate sharply or may grade into each other through colorless zones.

Equally bizarre are the tourmalines to which a similar array of colors is arranged concentrically about the long axis of a crystal, making successive "sleeves" of color around a central core—which is often pink or red. Less com-

TOURMALINE "sunbursts," like n photograph on opposite page, tly occur in metamorphic rocks.

Woven into the crystal group seen above are lithium tourmalines, smoky quartz.

monly, several colors—usually shades of pink, red, or green—are splashed in random fashion over the crystal.

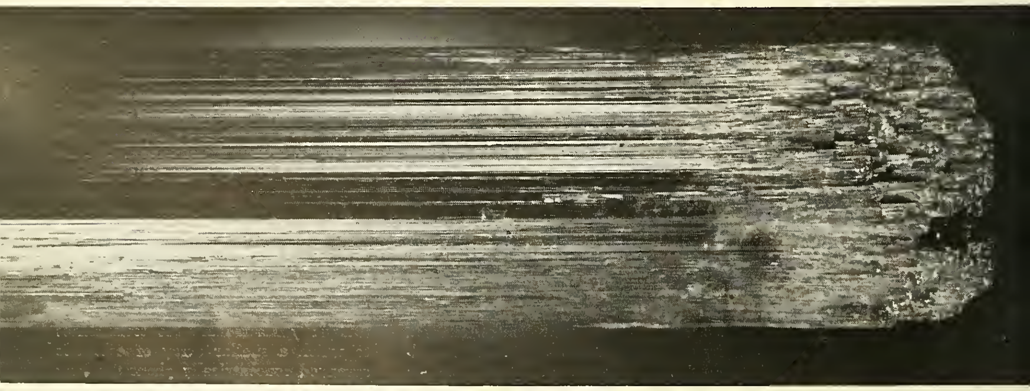
There are no ready explanations for the vagaries of such bicolored and multicolored tourmalines. It is generally assumed that each successive color of a specimen represents a change in the mineral content of the pegmatite fluids or "juices" that gave it birth, since chemical and spectrographic analyses of the different colors indicate small changes in composition. Thus, black, olive green, and the distinctive, brilliant "tourmaline green" are ascribed to the presence of relatively large quantities of iron. Red and pink tourmalines are thought to owe their hues to the element manganese, perhaps in combination with the alkaline metals lithium and cesium; while blue tourmalines may owe their coloration to minute traces of copper. The cause, or causes, of yellow tints has not been well established, although some analyses of yellow tourmaline have indicated that calcium and tantalum may have a part to play. In addition to these elements, others, such as gallium, tin, nickel, vanadium, and the alkaline-earth metal, beryllium, have been suspected of contributing to the range of coloration.

The mineral tourmaline belongs to one of the several classes of crystals that exhibit the phenomenon described as the "piezoelectric effect," first noted by the Curie brothers, Pierre and Jacques, in 1880. Briefly, the piezoelectric effect allows the conversion of mechanical energy into electrical energy. That is, a pressure exerted along an appropriate axis of a crystal results in the generation of a small electrical current, which varies in direct proportion to the amount of pressure applied. While this crystal property is not one exclusive to tourmaline, certain qualities of the mineral—its high mechanical strength and its chemical stability—make it unique among minerals as the basis for various piezoelectric gauges employed in measuring the intensity of shock waves, both in air and water. Thin slices of flawless tourmaline, appropriately cut, metal-plated, inserted into a housing, and connected with amplifying and recording instruments, are capable of making accurate electrical records of the form and intensity of shock waves—a valuable property, indeed, during these times when shock waves of one sort or another seem destined to play an increasingly important role in human affairs.

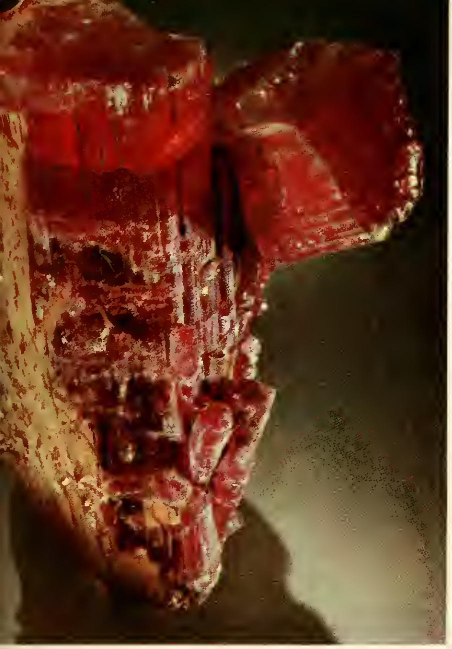
In addition to its piezoelectric property, tourmaline also exhibits a pyroelectric effect—the development, on heating, of positive and negative electrical charges at opposite ends of the crystal. There is no particular commercial significance connected with this phenomenon at present, but it is interesting t that it was in the mineral tour that the effect was first observed. and Rose investigated the pyroele properties of tourmaline during th dle of the nineteenth century. F one of the first American books o eralogy *(A Compendious Syst Mineralogy and Metallurgy,* prir 1798 by A. Bartram, of Philade noted that ". . . *tourmalin* [as th was then spelled] is a kind of hard lately brought into notice by its ele properties. . . . When heated . . . , signs of contrary electricity on t opposite ends of their [sic] pri form. . . . It is hard almost as the

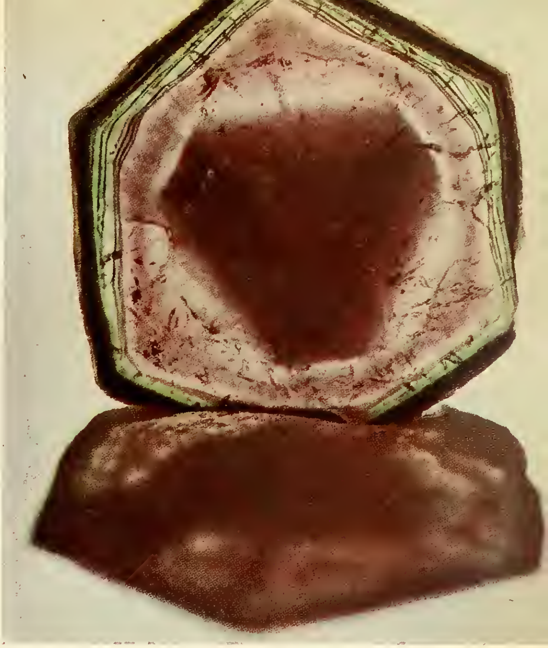
Paul Mason Tilden, formerly
Editor of Nature Magazine a
rock and mineral collector him
now continues his regular colum
the pages of the combined magaz

If tourmaline remains, in some re something of an enigma, it is theless a source of pleasure amateur collector—as well as author of the collector's field guic one of the more easily identified bers of the mineral kingdom, con occurring in well-developed cryst in rather predictable localities. field guide says that the cross-sec a tourmaline crystal should be t lar, the gathered specimen often a rough, or even a good, tria cross-section. If the manual ca myriad parallel striations alo prism faces of the crystals as a species diagnosis, the striation usually be found. In some of its characteristics, too, the mineral i than ordinarily predictable. F amateur in the field, it is a beac sea of strangely distorted crystal



Characteristic of tourmaline crystals that have developed in rock cavities, or "pockets," is the fine striation of prism faces, well exhibited in the Brazilian specimen seen here. specimens shown are from The American Museum's col



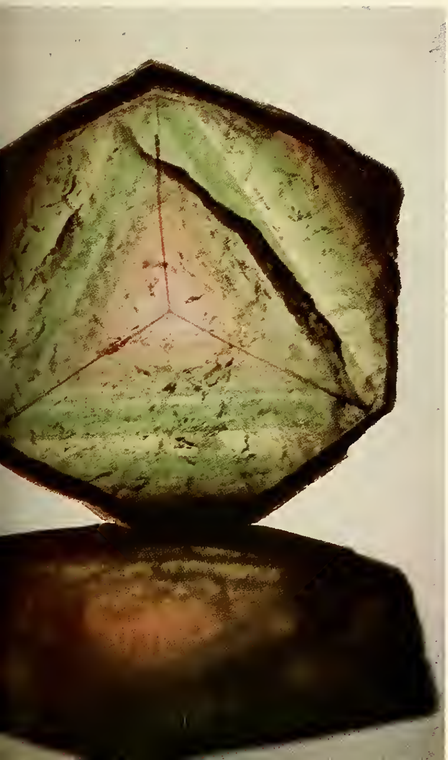


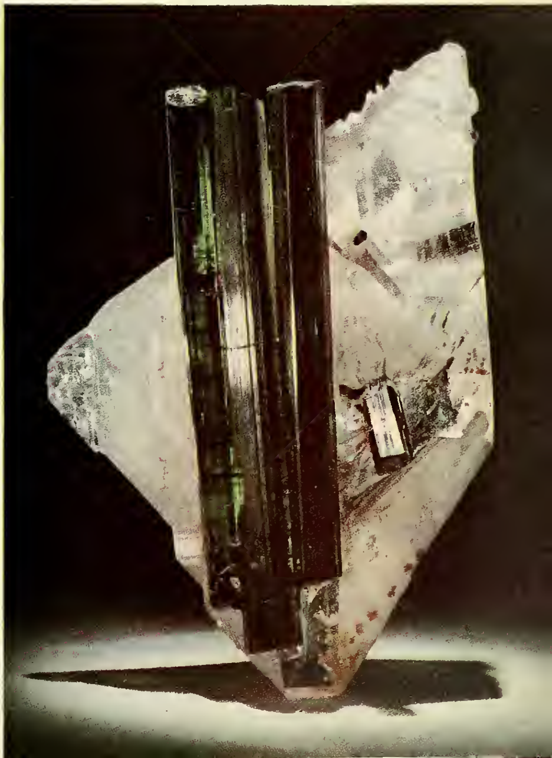
HIUM PEGMATITES of Southern California have furnished erous superb tourmaline groups as the one pictured, *above.*

CROSS-SECTION of the Madagascar tourmaline specimen, *above*, reveals the unusual geometrical pattern made by crystal core.

ERIOR PATTERN exhibited by the tourmaline section, *below*, vides visual clue to crystalline structure of the mineral.

GREEN TOURMALINE "pencils," like those adhering to quartz crystal, *below*, furnish gemstones called "Brazilian emeralds."





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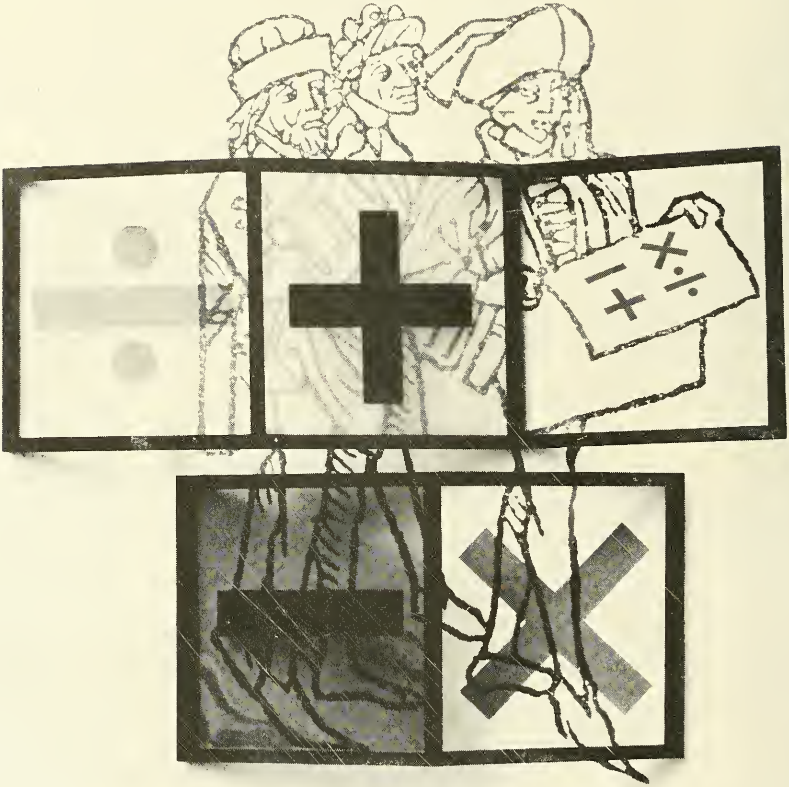

These simple signs express a powerful idea

When you first wrote 2 + 2 = 4, you were learning to use symbols that took men thousands of years to invent. Equations were all written out in words until a German teacher, Heinrich Schreyber, used + and − in an algebra book about 1520. A century later the × sign crept into arithmetic.

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Natural History

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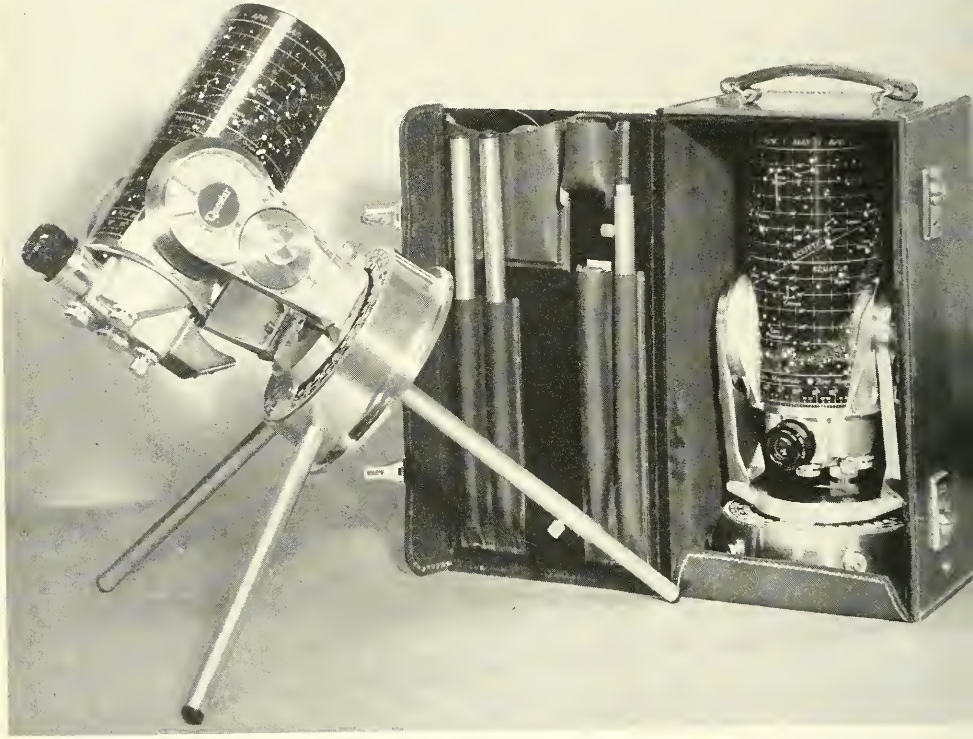
While playing the lead in the Broadway musical "Greenwillow," the distinguished American actor Mr. Antho Perkins phoned us from New York. We learned that he had used telescopes since boyhood, has a 4-inch refract and had practically memorized our booklet. He asked some questions and in June took delivery of a quartz-mirro Questar. When asked how he liked it, he said, "Your booklet does not do it justice." We asked if we could qu him in this space. "Indeed yes," he replied, "but change that to read 'no catalogue could do it justice.'"



LAY THAT BURDEN DOWN

When you finally get tired of lifting and carrying your telescope in and out of doors, tired of setting it up and taking it down in chilly darkness —

When you've had enough of heavy loads, of quivering tubes and images, enough of drives that falter and slow-motions that fall short —

When you finally realize that it has become too much trouble to use your telescope any more because it only gives you an aching back and a pain in the neck — when you've had your fill of the whole unhandy contrivance — *send for the Questar booklet!*

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But hold on — let the booklet tell you this — let us use this space to tell you other things.

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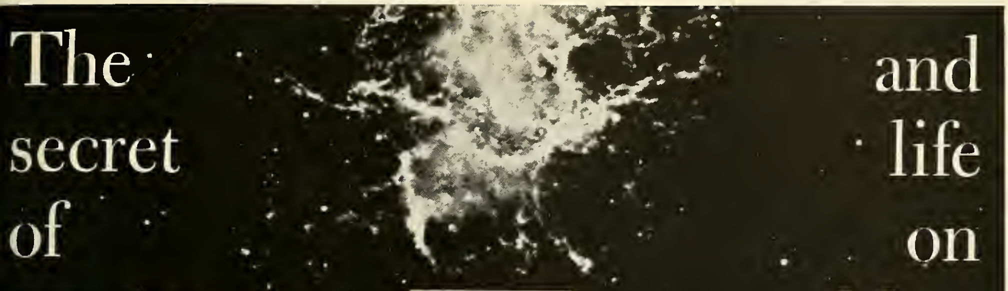
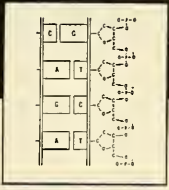


The secret of cancer— and life on Mars



Does this symbol hold the key to both?

Perhaps no other area of contemporary research excites scientists more than the one represented by the small symbol pictured above. It shows part of a molecule of deoxyribonucleic acid—DNA—the substance believed to carry the heredity "blueprint" of every living cell, animal and vegetable.

Because DNA alterations are now believed to cause cancer, biologists and chemists are hopeful that further DNA research will lead to conquest of the disease. Evidences of substances like DNA in meteors and other outer-space objects have bolstered astronomers' and physicists' belief in the probability of life on Mars and other planets. And many geologists and other specialists believe that DNA may provide at last the answer to the age-old mystery of the origin of life.

The DNA story is only one example of the interrelationships and interdependences which are the essence of modern science. Scores of other examples are presented by the distinguished biochemist and best-selling author, Isaac Asimov, in his major new two-volume work, THE INTELLIGENT MAN'S GUIDE TO SCIENCE.

Here for the first time you will see the myriad individual strands of inquiry and research masterfully interwoven so that the entire fabric of modern science is brought into brilliant focus. When you read THE INTELLIGENT MAN'S GUIDE TO SCIENCE you will find yourself saying not once but dozens of times, "*Now* I understand!"

LTHOUGH the literature of science includes innumerable specialized vol- nes and several fine encyclopedias, there s never been a book that makes the vast ectrum of modern science completely ible and understandable to the non- ofessional reader.

Such a book will at last be available th the publication of Isaac Asimov's HE INTELLIGENT MAN'S GUIDE) SCIENCE — a two-volume work ich takes as its subject the entire uni- rse of scientific knowledge but which ds with the excitement of history, the man interest of biography, and the sus- nsefulness of good fiction.

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Perhaps no one but Isaac Asimov could ve written this book. In the words George W. Beadle, the Nobel Prize- nning biologist: "Asimov is one of the e ones. He knows and understands ence in both its history and its sub- nce, and he writes simply, clearly and h infectious enthusiasm."

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You will learn how a finding in one branch of science often unlocked the barriers in others . . . how a mathematical formulation (Einstein's theory of relativity) paved the way for the first self-sustaining fission reaction and the beginning of the atomic age . . . how observations by astronomers with powerful modern telescopes helped geologists and physicists compute the age of the universe . . . how an 18-year-old student's attempt to synthesize quinine for use in treating malaria led to the discovery of aniline dye and the birth of a great industry. . . .

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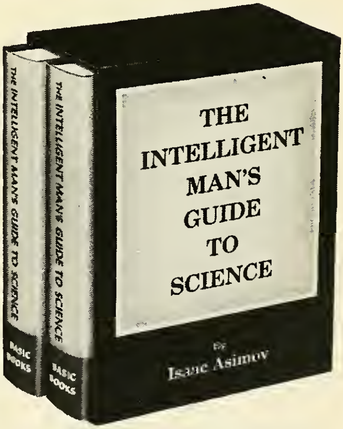
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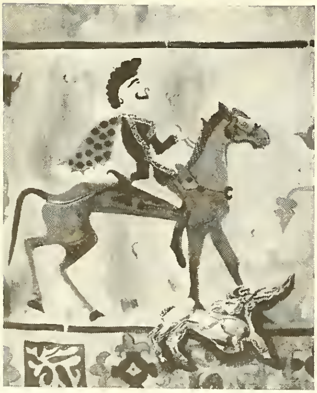

Natural Histor

Incorporating Nature Magazine

THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HI

Vol. LXIX OCTOBER 1960

ARTICLES

THE ROYAL SCYTHIANS *John F. Haski*
FOSSIL BONANZA *Georg Zapp*
THE AWESOME BONEBREAKER *James Ferguson-L*
CHILDREN OF THE FOREST *Colin Turnb*

DEPARTMENTS

MUSEUM MEMO *Alexander M. Wh*
REVIEWS
LIFE AT TIMBER LINE *E. Laurence Paln*
SKY REPORTER *Simone Daro Gossi*
YOUNG SCIENTIST *Richard A. Applebau*

COVER: Some time in the eighth or ninth century B.C., on the steppes of
Asia, an unknown Scythian had the idea of unhitching his horse from a
and mounting the animal. The age of the nomadic horseman had begun.
four centuries lightly armed Scythian cavalry ruled the plains from Lak
hash to the Black Sea. This month's cover, specially painted for NATURAL H
by Hans Guggenheim, shows one such warrior, drawn after a wall hangin
in one of the tombs of Pazyryk, in the Altai Mountains; in the foregrou
gold stag of typical Scythian design. For more about the Scythians, see

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Museum Memo

Beginning with this issue, NATURAL HISTORY invites its readers to visit behind the scenes at The American Museum through a new feature, Museum Memo. This informal report, coming to you several times a year, will carry news of Museum activities at home and in the field as well as plans for the future. In this first Memo, President White reviews significant developments of the past year. In December, the noted nature writer John O'Reilly will write of Museum people and their current projects.

ESEARCH conducted by American Museum scientists during the past twelve months spanned millions of rs and ranged from analysis of the myriad substances nd on the ocean floor to investigation of the galaxy. While a curator of paleontology was studying Triassic tiles at a site in New Jersey just three miles from the seum, word was received that a staff archeologist had covered a prehistoric city in remote Baluchistan, some 00 air miles distant. While one of our biologists was n diving off the island of Bermuda to study schooling avior in fishes, others were climbing 10,000 feet to the of Mt. Wilhelm on New Guinea to collect rare speci- ns of the island's fauna and flora. While one anthro- ogist was deep in an analysis of Stone Age cultures, ther was studying the impact of mass media on the erican high school student.

eadquarters for many of the research projects was the seum in New York, where scientists worked in the oratories that are hidden behind the exhibition halls l in the towers. Other programs were at the Museum's d stations: the Lerner Marine Laboratory in the hamas, the Archbold Biological Station in Florida, Kalbfleisch Field Research Station on Long Island, l the Southwestern Research Station in Arizona.

long with the efforts directed ard the increase of knowledge t the many Museum activities olved in the interpretation of ence to the public. Significant gress was made in our con- ction, exhibition, teaching, and lication programs. The new litorium was completed in the umn of 1959, and the library was moved to new rters in the early summer of this year. This library of .000 volumes, which ranks as one of the finest nat- l history libraries in the world, long ago outgrew its rters; books were being stored in odd corners through- the Museum. Now, books, catalogue, and reading room together with space for normal expansion. The new l of the Biology of Man, scheduled to open early in 1, was brought near to completion, and the Hall of rth American Birds was entirely reconstructed and de ready for the installation of exhibits. Work was un on renovation of the Hall of the Indians of the rthwest Coast, which contains one of the finest collections of its kind to be found anywhere in the world.

The American Museum-Hayden Planetarium marked the beginning of its twenty-fifth anniversary year with the installation of a new Zeiss projector, which greatly enhances the beauty and realism of the Planetarium sky.

OUR staff maintained a high level of publication in the four scientific series, the *Bulletin, Novitates, Anthropological Papers,* and *Contributions of The American Museum-Hayden Planetarium.* The quarterly journal of museology *Curator* entered its third year with subscribers in every state and in forty-three countries. The year saw the merger of *Nature Magazine* with *Natural History,* and the resultant expansion of content. Readers will share our pride in two awards for distinguished scientific journalism given this magazine in 1960. *Junior Natural History* initiated an editorial program to bring its readers a better understanding of the world's changing resources.

Educational services were expanded on a number of levels. The Museum opened an Evening School for Adults, and offered a lecture program that included archeology, ornithology, conchology, and botany. The Planetarium curriculum included specialized instruction in astronomy for teachers and engineers, as well as courses for laymen.

The encouragement of young people in the pursuit of science has traditionally been a concern of this Museum. The roll of scholars who served their apprenticeships here is noteworthy. Today, the need for training scientists is recognized as one of the urgent problems facing our country. New programs are being initiated to develop the scientific abilities of our college and high school students. Both The American Museum and The American Museum-Hayden Planetarium were selected by the National Science Foundation for participation in programs designed to acquaint undergraduates with research. The Museum program enabled students to work directly with staff scientists on field and laboratory projects. The Planetarium offered high school students an intensive summer course in astronomy and space sciences.

As this brief summary may indicate, the past year has been full and productive at The American Museum.

ALEXANDER M. WHITE,
President

e American Museum is open to the public without charge every day. Your support, through membership and contributions, kes this possible. The Museum is equally in need of support for its work in fields of research, education, and exhibition.

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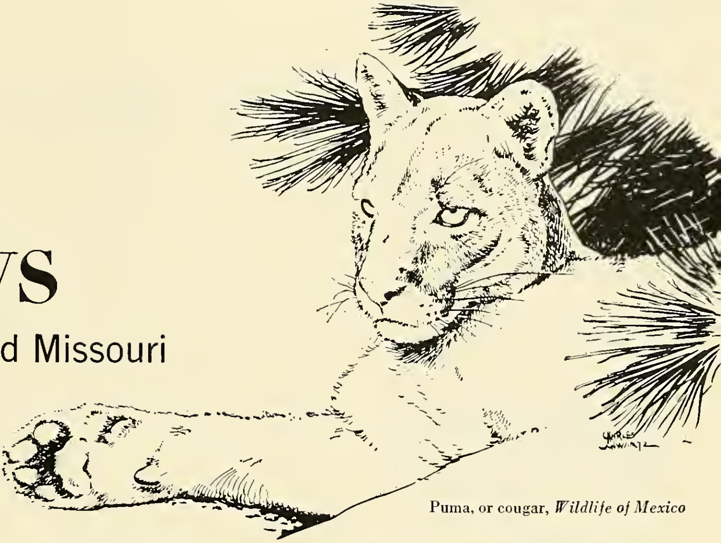
Reviews

Vildlife of Mexico and Missouri



Puma, or cougar, *Wildlife of Mexico*

ILDLIFE OF MEXICO. The Game Birds d Mammals, by A. Starker Leopold. *niv. of California Press, $12.50; 568 ., illus.*

N A RECENT FIELD TRIP through the southern uplands of Mexico, I made me mental notes on the condition of e countryside as seen from the highay. The pressures of human needs were ident all about me; they were rected in the ways in which the land was ing misused. The people in the village st passed were obviously "land huny" since there was not enough land in e valley to grow their crops, they had rned to the forested slopes and a mouninside that should have been retained forest had been cleared and planted corn. In the course of a single sean, much of the thin topsoil had been shed into the valley below, but the richment of the valley fields is only mporary: floods will soon deposit a rile blanket of gravel over all, and en the productivity of even the valley ll suffer. Farther along the highway, noticed that clearings of this sort had eady been abandoned, and the farms had moved higher up the slope to to compensate for their losses.

The future of such a village is not difult to imagine. The stream will no nger supply fish—it becomes a raging rent in the wet season and disappears neath a baked mud plain during the y season. The naked hillsides will no nger support white-tailed deer, forrly an important source of meat for e populace. On the gravel-washed val floor, the coveys of quail will be wer in number and smaller in size, d the ducks that formerly found sustence in the ponds and irrigated fields ll gradually but surely disappear.

Having raped their land and left it naked in this fashion, some of the villagers will gradually move up the valley in search of new territory where they will apply the same practices. Others may remain and resort to raising burros and goats on the abandoned farmland. These animals will graze on the scant vegetation and pack the soil into an impervious hardpan, until virtually no recovery of the natural flora is possible.

I continued down the valley and soon came to an irrigation and power dam, no doubt built at great expense to the Federal Government. Erosion from the misused land above it has been rapidly silting in the impoundment and must certainly be causing great inefficiencies of production of both crops and power. This situation could have deleterious effects to local industry and, when duplicated many-fold as I later found to be the case, to the national economy.

These observations on the plight of Mexican land use and its disastrous effect on the wildlife—indeed, on the economy of the country—reminded me at once of the concern expressed for the misuse of land in our own country in the writings of Aldo Leopold, the well-known American forester and game manager. I think particularly of an essay in *A Sand County Almanac*, in which he expressed reservation about the "solvency" of an Illinois farm:

"Everything on this farm spells money in the bank. The farmstead abounds in fresh paint, steel, and concrete. A date on the barn commemorates the founding fathers. The roof bristles with lightning rods, the weathercock is proud with new gilt. Even the pigs look solvent. The old oaks in the woodlot are without issue. There are no hedges, brush patches, fence rows, or other signs of shiftless husbandry. The cornfield has fat steers, but probably no quail. The fences stand on narrow ribbons of sod; whoever plowed that close to barbed wires must have been saying, 'Waste not, want not.' In the creek bottom pasture, flood trash is lodged high in the bushes. The creek banks are raw; chunks of Illinois have sloughed off and moved seaward. Patches of giant ragweed mark where freshets have thrown down the silt they could not carry...who is solvent? For how long?"

Years earlier, Aldo Leopold had presented this concept as the central thesis of game management, in his book of that name:

". . . game can be restored by the *creative use* of the same tools which have hitherto destroyed it—axe, plow, cow, fire, and gun." That the use of these tools in our own country has all too often been far from creative is obvious. One wonders what degree of creativity we have the right to expect from our neighbors below the border?

A truly outstanding book has recently been published that makes a plea for the wise use of land and habitat in Mexico. It is perhaps fitting that the author is A. Starker Leopold, son of the man who spoke first and loudest in our own country for wise land utilization as the way toward better game management.

This volume on the game animals of Mexico is the first in which an author has been able to combine professional biological training with personal field investigations. It has been over twelve years in preparation. In 1944, Starker Leopold was employed by the Pan American Union to initiate a survey of Mexican wildlife. William Vogt, another prominent figure in the field of conservation,

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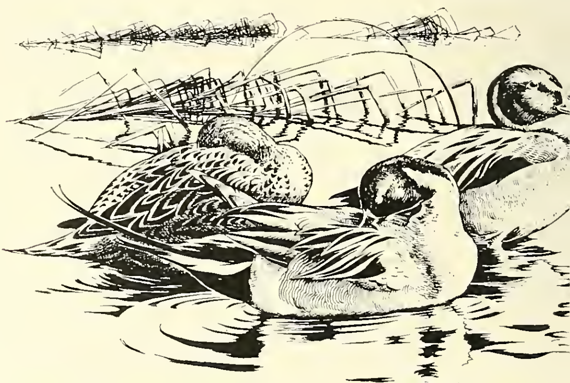
was Director of the Conservation Section of the Union at that time. Two years later, Leopold joined the staff of the University of California, where he now holds a professorship in Zoology and is Associate Director of the Museum of Vertebrate Zoology. Each year, he continued to spend a month or more traveling in various parts of Mexico to observe the wildlife, to accumulate notes on its biology, and to collect specimens where needed to document locality records. In addition to numerous photographs, the book is delightfully illustrated with drawings by Charles W. Schwartz.

Approximately one-fifth of the book is devoted to a general treatise on the topography, climate, and vegetation of the country, and a frank discussion of the impact of human use upon the Mexican landscape. Ecologists and biogeographers will recognize the material on the vegetation zones to be an abbreviated version of the author's earlier study that was originally published in the journal *Ecology* in 1950. Corrections have been made in a number of details, but the vegetation map remains essentially as it appeared in the earlier article and is the best of its kind available for Mexico.

Leopold's analysis of the current government program of wildlife conservation in Mexico, with suggestions on how it could be improved, carries a message from which officials in U.S. Government circles, as well as Mexican authorities, might well profit. To be sure, an important limitation in the existing Mexican program is the lack of funds and organization with which to execute and enforce the regulations; but Leopold makes it clear that he considers the program's greatest shortcoming to be the emphasis it places upon regulation of hunting rather than upon the condition of the habitat and habitat management. The argument over the value of predator control as a means of increasing game is a perennial one. Leopold, for his part, concludes that game populations are more effectively controlled by the
dition of the environment than th
the tremendous sums of money spe
restricting hunting. I noted, in pa
that under the existing Mexican
laws, all wildlife is considered the "
erty of the nation." In the U.S. r
tory birds are regulated by the Fe
Government, but all resident wil
mals are the concern of the states.

About three-quarters of the bo
comprised of species accounts o
game birds and mammals. Had Le
interpreted "game" to mean all th
cies actively hunted, he would hav
to treat nearly all the birds and
mals of the country, for even son
are taken "to supplement the bea
in most localities. Instead, his cov
is essentially based on those specie
sidered to be game in the 1954 v
of the Mexican game law. Parrots,
ground squirrels, and gophers hav
omitted. The table of contents
seventy-one species of birds and fif
species of mammals. Additional s
are considered briefly in the text, i
ing some of the shore birds an
closely related forms of chacha
quail, doves, rabbits, agoutis, and sk
The status and management of
fowl, the most important group of
birds in Mexico, receives special
ment. No consideration is given t
species or geographical races. T
the average species account is o
two pages in length, plus a full
illustration including range map.
of the more important game specie
as the turkey, gray squirrel, grizzly
and white-tailed deer, have been al
four to five pages of text. The foll
points are considered under each s
account: (1) local names, (2) de
tion, including weights and me
ments, (3) distribution, includ
range map on which actual reco
occurrence have been plotted, (4
tural history, in so far as know
(5) present status in Mexico, wit

(Continued on pa



Ducks, also from *Wildlife of Mexico*

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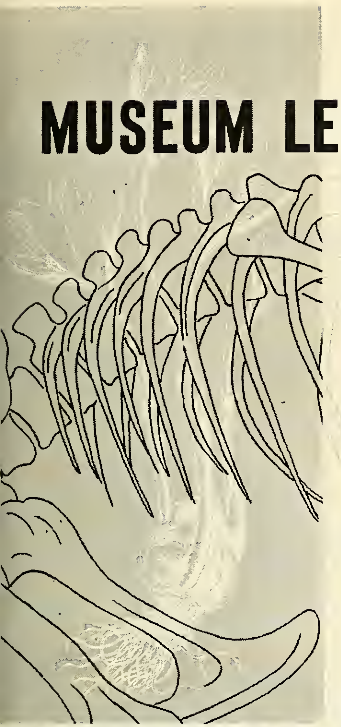

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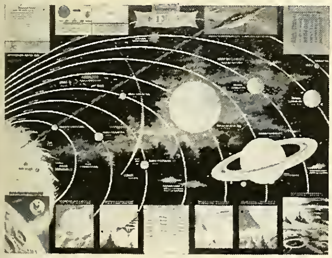

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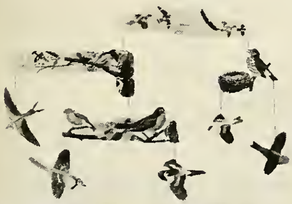

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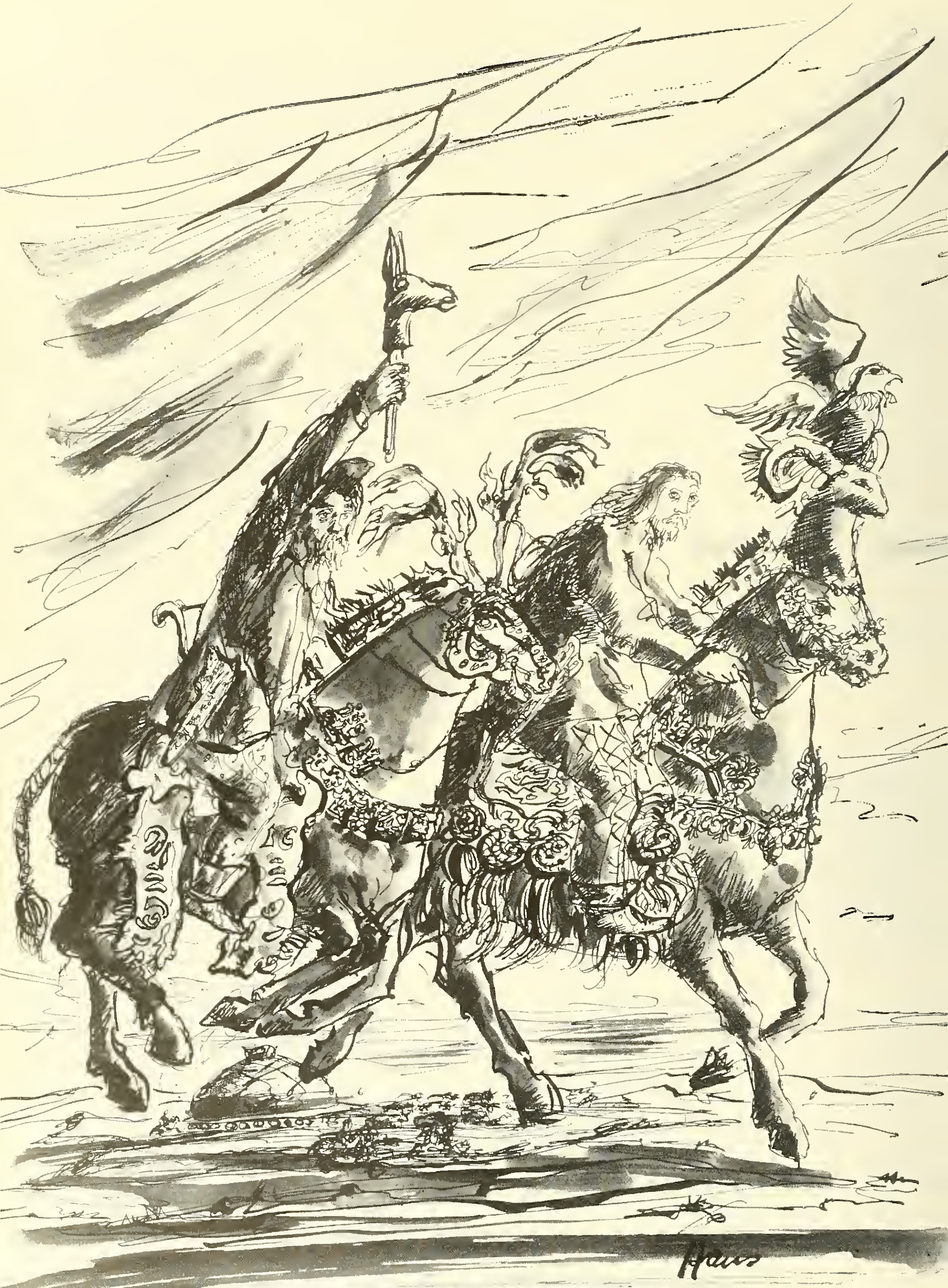
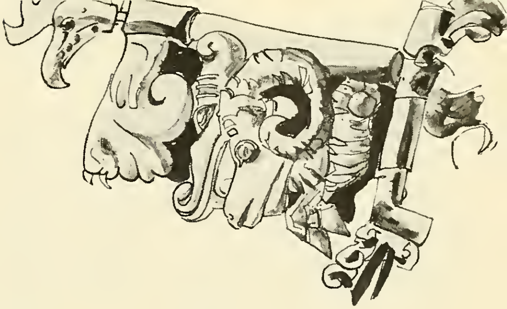

Haas

his nomadic people formerly
anged the Old World steppes



The Royal Scythians

By JOHN F. HASKINS Illustrations by HANS GUGGENHEIM

HE WORLD OF SCIENCE IN GENERAL, and Russian science in particular, owes a great deal to the unwitting actions two men. One of these men would have been recorded history even had he died on the day of his birth, for he s the son of an emperor. But he lived—to become Peter Great, Tsar of all the Russias (1672-1725). The other s the son of a fisherman: even the day of his birth uncertain. Mikhail Vasilievich Lomonosov by name, he ew to be a scientist, poet, and statesman. He died in 65, having served for a year as Secretary of State to the npress Catherine II, and was thought to have been fifty-ır years old at his death.

As was the case with many another monarch of the "Age Reason," Peter the Great had a spirited, if untutored, erest in antiquities. One of his famous ukases, concern-; archeological treasures, claimed all objects found be-ıth the soil for the Russian Crown. Mikhail Lomonosov s trained abroad, in Germany and France. When he urned to Russia, as a professor of chemistry at the new perial University at St. Petersburg, he began to work h the Russian language, revising the cumbersome syntax Old Church Slavonic and making of his native tongue a ıguage of poetry. In addition to his writings and scien-c work, Lomonosov sponsored the formation of various llections of *Wunderkammern*—"curiosities"—that be-ne, in turn, the bases for several Russian museums of tural history. It was largely his effort that caused Russian become one of the languages of science.

Toward the end of the seventeenth century, news reached oscow of the discovery of gold in the new territories of peria. Not only was the precious metal found in its nat-ıl state, but curiously wrought objects of gold, fabulous value, were also being discovered. Much of the early ospecting was performed by Swedish prisoners of war, ıt to Siberia during the wars with Charles IX. As one of se prisoners records, bands of as many as three hundred uld set out to pilfer so-called "Tartar" graves. Any num-r of the pieces thus discovered went straight into the melting pots of local goldsmiths, but some of the golden objects were purchased by Nicholas Witsen (1641-1717), a Dutch fur trader and diplomat, who traveled in Siberia at the turn of the century.

Witsen smuggled his collection out of Russia to Holland (where it disappeared without a trace after his death). A part of the collection, however, was published posthumously in the third edition of his book, *Noord en Ost Tartarye*, which was one of the first works printed in Europe to describe the vast reaches of Siberia. Witsen's discoveries excited the interest of Peter the Great and the new tsar began a Siberian gold collection of his own. The result is the so-called "Siberian Gold Treasure of Peter the Great," now one of the prized exhibits of the Hermitage Museum in Leningrad.

IN 1715, a wealthy nobleman named Nikita Demidov, a serf's son and a blacksmith who—as an armorer—had become a favorite of Peter, and who owned rich mines east of the Ural Mountains, assembled a collection of these Siberian gold art objects. Demidov presented them as a gift to Tsarina Catherine I, on the occasion of the birth of the ill-fated Tsarevitch Peter Petrovich. Demidov's gift was appraised—in gold value alone—at a hundred thousand rubles. The following year, Prince Gagarin, the governor of Siberia, sent fifty-five "sets" of gold to the capital. The catalogue of the Gagarin Collection still exists: in it are listed eighty pieces that, together, weighed more than sixty Russian pounds (about fifty-four pounds avoirdupois).

These objects, representing a type of art that came to be called the "wild beast" or "animal" style, are now known to be the work of Eurasian nomads who roamed the steppes during the last millennium before the birth of Christ. The objects—and the culture that produced them—remain as controversial today as when they were unearthed more than two hundred years ago.

Some fifty years after Peter received his gifts of Siberian gold from Demidov and Gagarin, an army officer on duty in South Russia, General Alexis Melgunov, became interested in a curious group of tumuli that he had observed near Elizavetgrad, between the Bug and Dnieper rivers. In September, 1763, he ordered one of them opened and

HLY ACCOUTERED Scythian horsemen roamed the plains of ia and the Crimea, ruled from ninth to fourth century B.C.

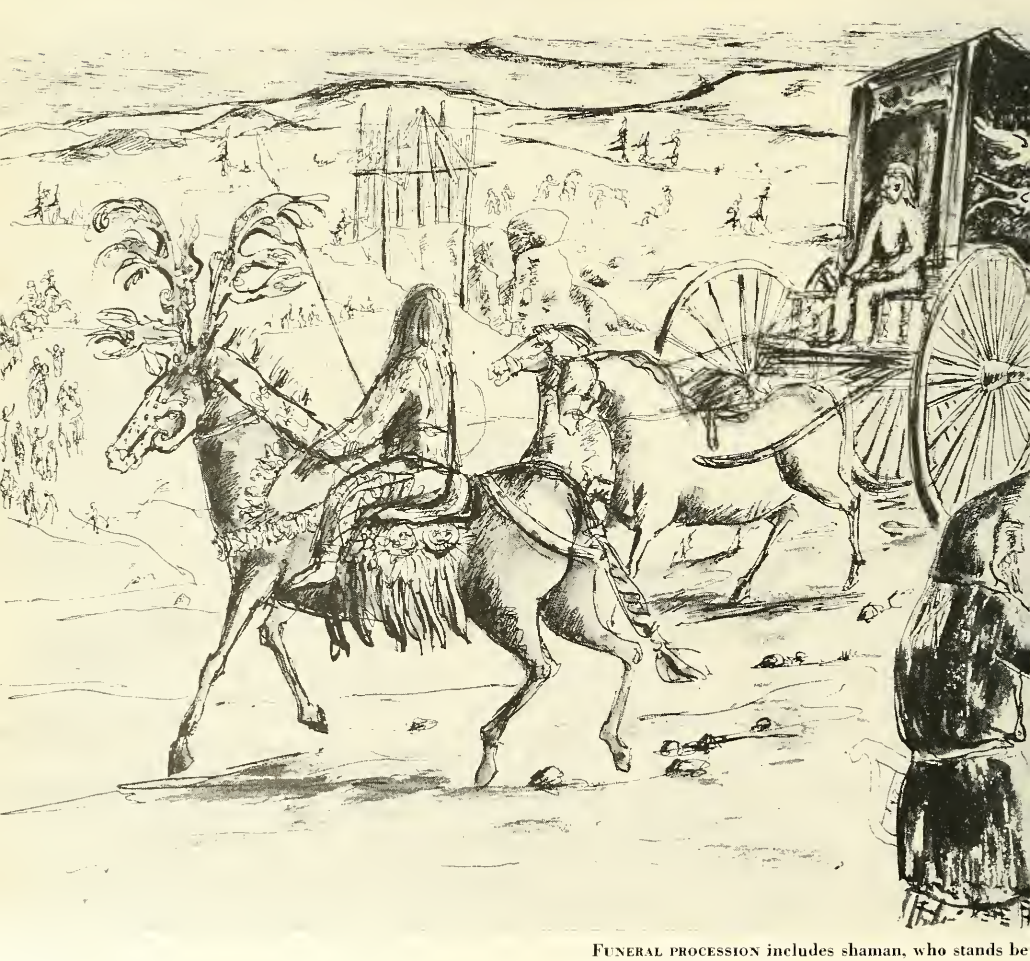
began the first of a series of breath-taking discoveries. The tumulus he had excavated now bears his name. It proved to have been a Scythian tomb, which he called *Litoi Kurgan*, the "tomb of the Scythian cast."

Melgunov, unfortunately kept no records of his discoveries, and immediately posted the gold treasures that he had unearthed to the new Empress Catherine II. We know today that the Melgunov kurgan was the tomb of a Scythian chieftain who lived in the late seventh century B.C. It was the first and earliest of a series of tombs that dotted the landscape of South Russia, the Crimea, the Taman Peninsula, and the Kuban. Melgunov had discovered the tombs of the Scythians and a people long believed to have been creations of myth were brought to life again.

THE third verse of the tenth chapter of Genesis lists the Ashkenaz (Scythians) as sons of Gomer. The latter were probably the Cimmerians. The Scythians appear again

—as Ashguzai—in the royal Assyrian correspondence
know that Scythian cavalry fought beside the Mede
Persians at the destruction of Babylon, and that they
supposed to have ruled "Asia" (modern Iran?) for tw
seven years. They would seem to have reached as far
as Egypt at some time, but it remained for the Halica
sian historian, Herodotus, to give the most complet
count of them. The historian had actually visited a tr
colony at Olbia—near the confluence of the Bug and
per—during the fifth century B.C. and had spoken t
Scythians living there. At that time, they exercised a
rule over the vast area around the northern shores o
Black Sea, in what is now South Russia and the Uk

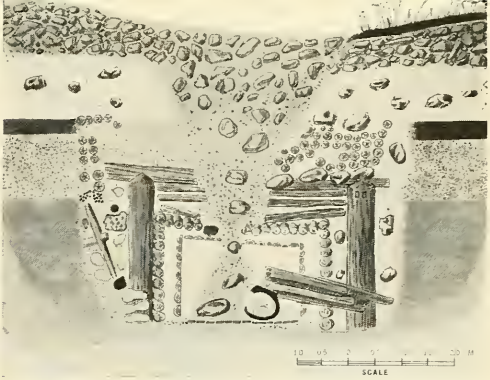
Herodotus dedicated his nine books of history t
Muses. He called his fourth book *Melpomene* and its
ters contain one of the most engrossing stories in hi
The book begins with an account of the attempt (in 5
513 B.C.) of Darius the Persian to conquer Scythia



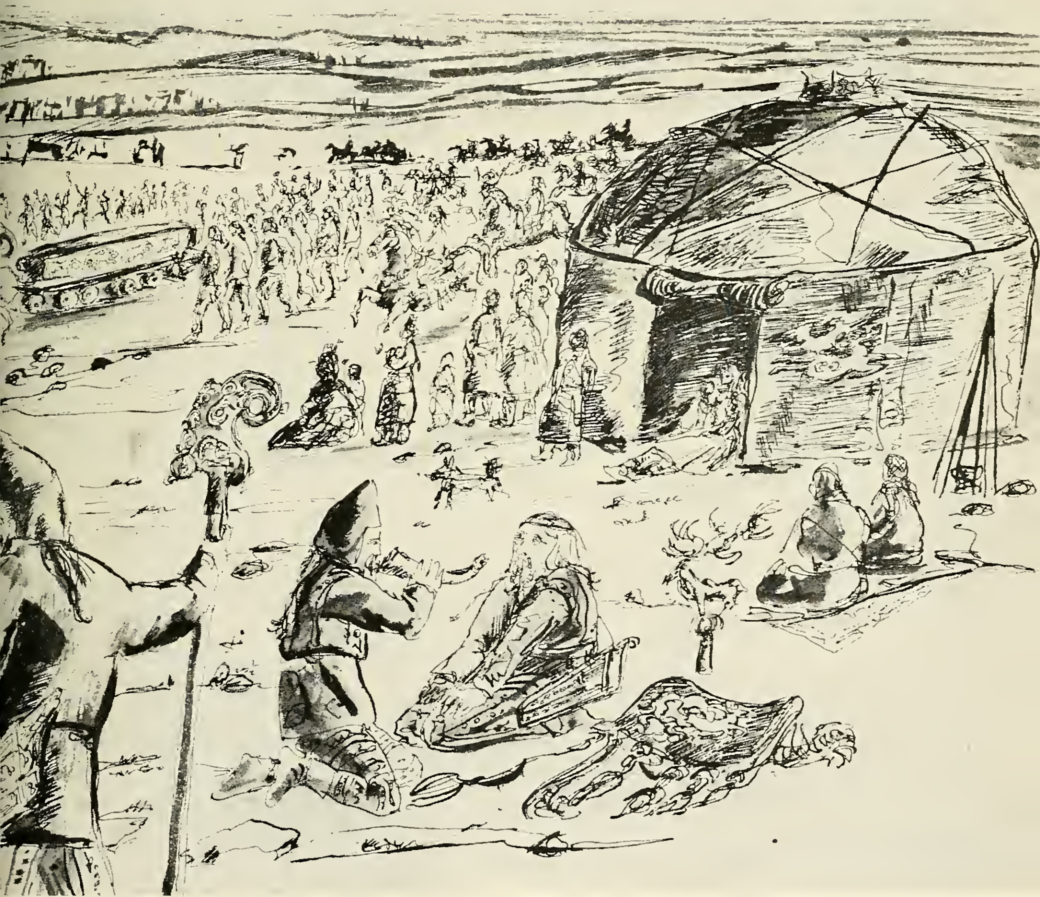
FUNERAL PROCESSION includes shaman, who stands be
richly carved coffin and felt-covered cart of a type still

lude to an invasion of Europe. The geographers of an- ity applied the label of "Scythia" to the whole of what ow Russia and, by extension, the people who lived there e called Scythians.

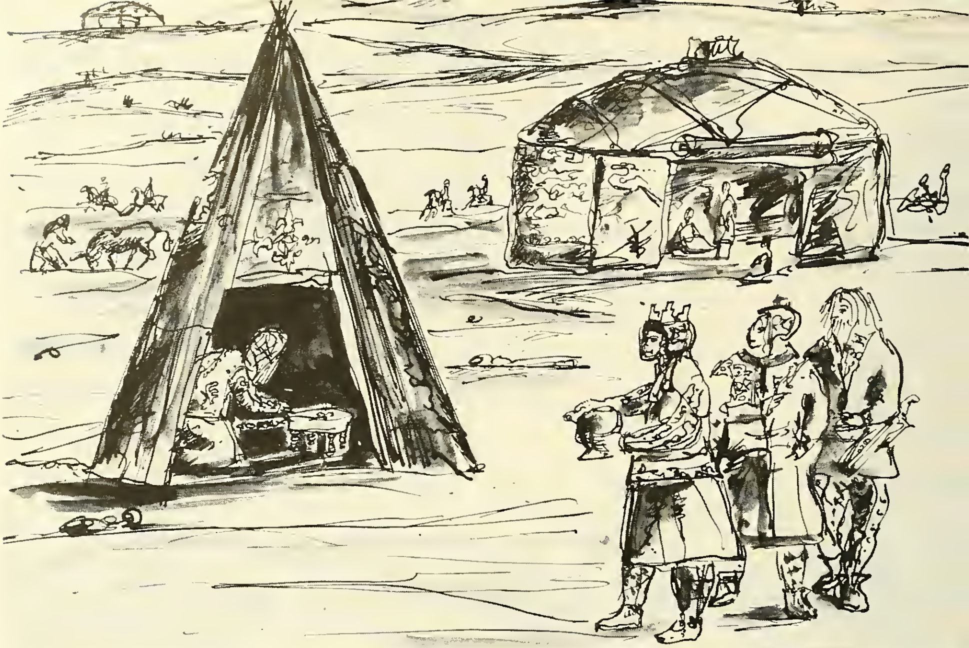
Herodotus listed five separate Scythian tribes, one of om he called the "Royal Scyths," or *Paralatae.* He stated t their tribal name was *Scoloti,* but "... the Greeks, how- r, call them 'Scythians'..." and, again, "... the Per- is call them *Saka*...." We only wish he had said why, this is one of the great historical mysteries. "Scythian" ot a Greek word, and there seems to be ample evidence t *Saka* was not primarily Old Persian. In modern Iran- *sag* means "dog." Thus the name we know now as ythian" may have been the transliteration of some tribal ne or title, and may properly apply only to a small group eople at one particular time—let us say, the builders of gold-filled royal tombs around the northern shores of Black Sea, in the last seven centuries before Christ.



Chief's grave near Pazyryk is seen in cross section above. Ice had preserved ancient objects until discovery in 1928.



Outer Mongolia. Scaffolding for tomb is seen in rear left; ses will be buried on upper level, Scythian chief below.



Inhaling hashish fumes, a Scythian woman in tent at left kneels beside a caldron containing hemp seeds and spices placed on heated rocks. The ritual was first describ
Herodotus, who wrongly took it for a form of steam ba

There is no clear date for anything in Scythian history. We are not even certain when Herodotus sat at Olbia and listened to the Scythian merchants tell of their past. This was probably about the middle of the fifth century B.C., at least two centuries after the Scythians' first real power was established. Herodotus gives several accounts of the origin of the Scythians, ending with one that he said he himself believed. He stated that the Scythians came from Asia, after having been defeated by the Massagetae. The Scythians then entered the land of the Cimmerians and drove the latter away, establishing themselves in Cimmeria (probably the modern Kuban).

We may find some confirmation for this story in another, older work of history—one that was written many thousands of miles away from the classical Scythia that Herodotus knew. One of the world's oldest historical records is the *Shu Ching*, or *Book of Documents*, which purports to be a history of China from the time of the Creation until the time that the work, itself, was written. While much of the *Shu Ching* was actually set down in the fourth century B.C. and some of it dates only from the Wei period (*ca.* A.D. 324), a good deal of the work is believed to have existed at least as early as the eighth century B.C. One of its chapters lists the tribute brought to the Emperor Yu of the Hsia Dynasty (traditional dates: 2205-1766 B.C.). The nineteenth line of this chapter begins: "The felt-weaving Western Barbarians: the *Hsi-chih* and *Ch'iu-sou* from the ranges of the *K'unlun* Mountains, presented themselves in that order. . . ." Some scholars now believe that the tribute-bearing *Hsi-chih* were the "Royal Scyths" of Herodotus' later history. Scythian domination of their Black Sea holdings ended some time around 338 B.C., when the Sarmatian
tribes moved westward across the Don. How long th
thians had ruled their lands before this is not know

What was the actual history of the Scythians?
light of present archeological knowledge, a tentative
struction may be attempted. Some time, probably
ninth or eighth century B.C., somewhere on the st
presumably between Lake Baikal and Lake Balkha
unsung genius unhitched his horse from a charic
mounted the animal. The age of the centaur, cavalr
and cowboy had begun. The mounted horseman wa
bile: not restricted to roads and tracks, he could roa
vast prairies of Central Asia. Freed from depende
farmlands, as the Chinese historians tell us *(Han-sh*
A). "He could follow his flocks from place to
having no settled abode. . . ." Nor could it have bee
before the pastoral nomad became the warrior nom
was not difficult even for a barbarian to see that the
of settled communities could be extremely profitabl
Chinese Dynastic Histories from the Han (206 B.
220) to the Ch'ing (A.D. 1644–1912) provide a d
account of the monies spent—often without success
attempt to keep barbarian horsemen of a wide vari
origins safely beyond the Great Wall. On a least six
sions, these histories tell us of times when a "barba
chieftain succeeded in seizing the ". . . vermilion
of supreme authority . . ." and mounting the ". . . D
Throne of the Son of Heaven."

Some time after the felt-weaving *Hsi-chih* had pre
tribute to the Emperor Yu, and some time
Darius' planned invasion of Scythia, these nomad
managed to wed Chinese imagination to their own a

ntasies. These latter may have derived from "hunting agic" or from some form of totemism. Whatever their igins, they have provided us with an art that is as vital ıd alive today as it was more than two thousands years ;o. The artistic style that so excited Peter the Great and ptured General Melgunov's imagination was to form the ısis for European medieval heraldry and much of ecclesi- tical symbolism. The gargoyles that glare down into the reets of Paris from the stringcourses of Notre Dame, the eat dragon heads on the prows of Viking boats, and the raldic wivern are all related and—by not very elastic tension—are all Scythian in origin.

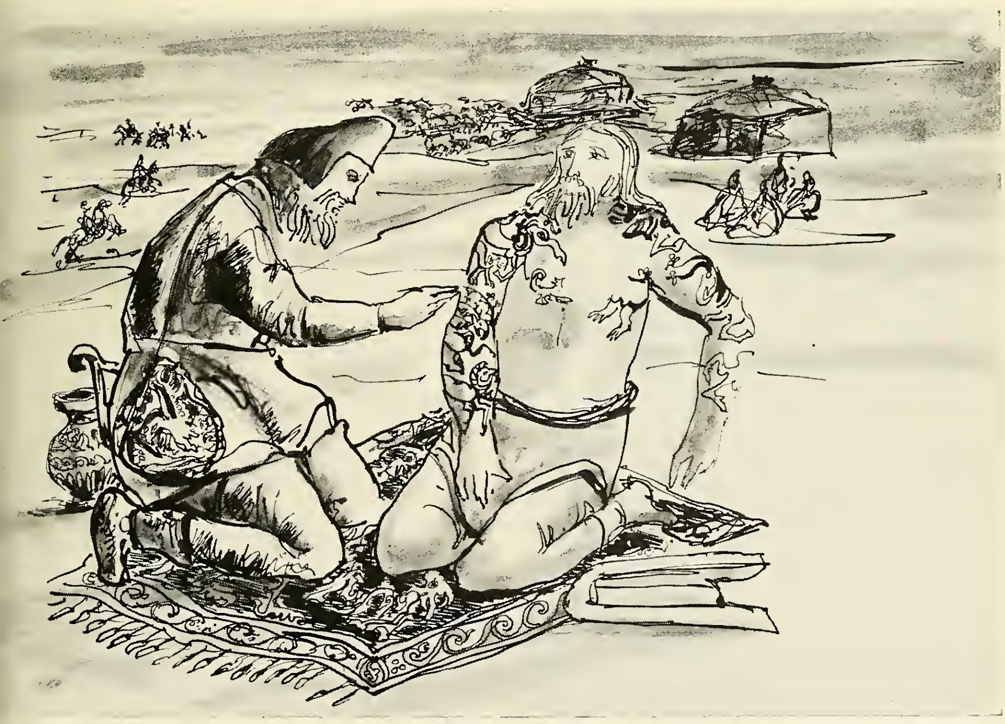
What do the ancient accounts tell us about the Scythians? one way we know quite a good deal, although Herodotus ve no physical description of them, and that given by e Greek physician Hippocrates is rather confusing. The tter said that the Scythians were all fat and jolly. They d no beards and were subject to the "woman's sickness," disease inflicted on them by Aphrodite as a punishment r their having plundered a temple of Astarte while they ere in Syria. When they caught this disease, men donned omen's clothing and behaved as wives to other men.

Hippocrates was a medical man, interested in the unual: the Scythians he described were certainly not charteristic of all Scythians. Although he did not know it, he d given, en masse, a perfectly accurate description of an dividual berdache, a sort of "supershaman." Such transstite customs have been recorded among present-day dian tribes of America and the peoples of Asiatic Siberia. The berdache were called *Enarëes* by the Scythians: they were soothsayers, who told fortunes by means of willow wands, which they would twine about their fingers.

Unlike many other Eurasian nomads, the Scythians by historical account seemed to have kept their women in seclusion. They did not, as did the Sarmatian girls, ride to combat with their men. The Scythians lived in yurts, felt tents that they would mount on wheeled platforms, and have pulled along by oxen or draft horse.

WHAT else do we know about the Scythians? The spectacular electrum vase from the tomb at Chertomlyk and the golden jugs from the Kul Oba barrows—as well as several small sculptures from the same site—all show Scythians engaged in various activities: breaking horses, pulling teeth, or stringing bows. One of the most beautiful monuments in art is a golden comb from the kurgan at Solokha. It dates from the end of the fifth century B.C., and shows two foot soldiers in Scythian dress fighting a lone cavalryman, while a dead horse is trampled underfoot. The comb was probably made for a Scythian chieftain by a Hellenic workman, but it was to Scythian taste.

As depicted, these people seem to have been rather small and stocky men, with long, curly beards. From Persian inscriptions, we know that they sometimes wore tall pointed caps, but as often they seem to have gone bareheaded. Accounts say that they loved bright colors and wore short jackets with tight sleeves, long trousers, and soft felt boots. They carried their bows and arrows in a single quiver—

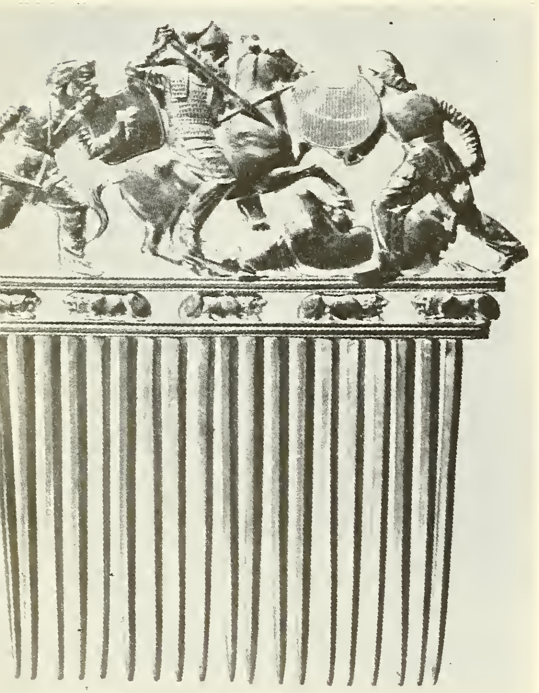


ATTOOING was a practice among the Scythians, although holars do not know whether it was used only by shamans and chiefs, or whether purpose was to identify the tribe to which a man belonged. See also the picture on page 15.

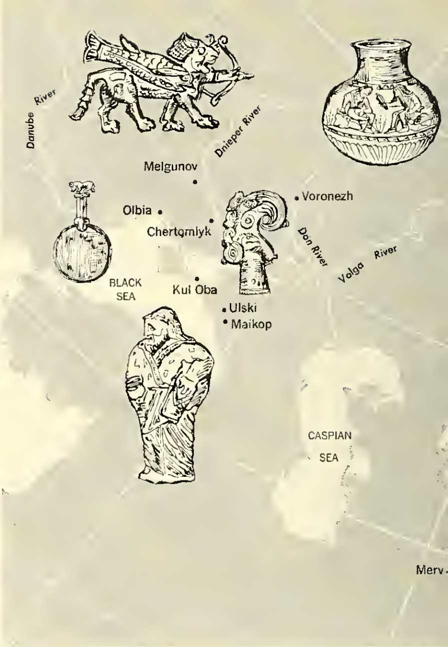
called, as we know from Herodotus' account, a *gorytos.* They wore their short sword—the *akinakes*, in its distinctive sheath, the *mikes*—on the right instead of the left side. The scabbard was tied to the thigh to facilitate a fast draw. Their favorite weapon, next to the bow, was a form of fighting pick they called a *sagaris.*

We are told that it was the Scythian custom to scalp the enemies they had killed in battle, and to hang the grisly trophies on the harness of their horses, using the scalps as napkins. Another savage trait was the fashioning of drinking goblets from the skulls of fallen foes. Poorer clansmen covered these skull-cups with leather, but the wealthier Scyths lined their trophies with gold. Chinese records tell us that the *Hsiung-nu* (Huns)—who raided the borders of China during the Han Dynasty—had a similar custom.

THE descriptions of Scythian life in the Greek histories, combined with the discoveries of Scythian tombs in South Russia and those of non-Scythic peoples who shared a similar way of life in the high Altai, give us a quite good picture of the customs of the Eurasian nomads during the whole of the last pre-Christian millennium. We know of the custom of the exchange of blood-brotherhood (thrusting a knife through the hand and letting the blood flow into a cup of wine, which was then drunk by the two participants in the ceremony). We have evidence—from tiny, gold statuettes at Kul Oba—of ritual wrestling. We know of the practice of trepanning and embalming the dead. We know that the Scythians sometimes tattooed themselves—and gave as



Gold comb found in one Scythian tomb is of Greek make, and depicts two Scythian foot soldiers fighting mounted foe.

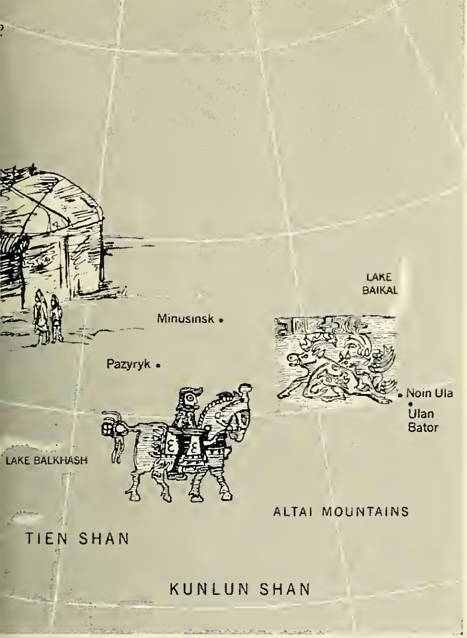


Range of Scythian domination is shown in map loc
some of chief archeological sites. Scythians are thoug

much attention to the artistic details of the "animal" in this curious art as they bestowed upon their fun vessels. Remains have been found of their yurts, w were hung with gaudy tapestries and carpeted with finest materials from Persian and Central Asian lo Horses have been found buried in all their barbaric fi supplied with caparisons and horned chamfrons (ma that outshine the trappings of Europe's medieval kni

A most interesting detail—one of the few, though un standable, mistakes in Herodotus' account of the Scyt —has been verified time and again by excavation. Greek historian alluded to a curious custom of "bath in which the Scythian men and women would enter a s felt chamber and throw heated rocks into caldrons with seeds of the hemp, anise, and other spices. We k today, from the discovery of just such chambers in Sib tombs of the fifth century B.C., that Herodotus has giv an accurate and very early description of the use of has The fifth tomb of the Pazyryk complex, in the Altai M tains, has presented us with a tapestry showing just su scene and the crowned ladies who participated in this ri

NAMES of gods, personal names, and the few Scyt words listed in the histories lead to the conclusion these nomads' language was Indo-European—possibl lated to Old Persian, or at any rate to some Iranian to Herodotus stated that *arima* meant "one" in Scyt speech. This may compare with the Zendian word *ai* which means "loneliness." The Scythians reportedly c a tribe of women warriors the "man-killers"; in Scyt *Oiorpata. Oior* was the Scythian for "man," and *pata* m "to slay." The late Sir Ellis Minns, however, has po out that what the Scythians may have been trying to



ve begun expansion from somewhere between Lakes Balk-sh and Baikal; their culture reached its zenith in Crimea.

s "Lords of Men" (from *paiti*, "lord"). Certain rivers in ssia may still have Scythian names: *dan*, meaning ver," was an early name for the River Don, and the ver Bug may take its name from the Scythian *bugh*, od." after the Iranian *baga*.

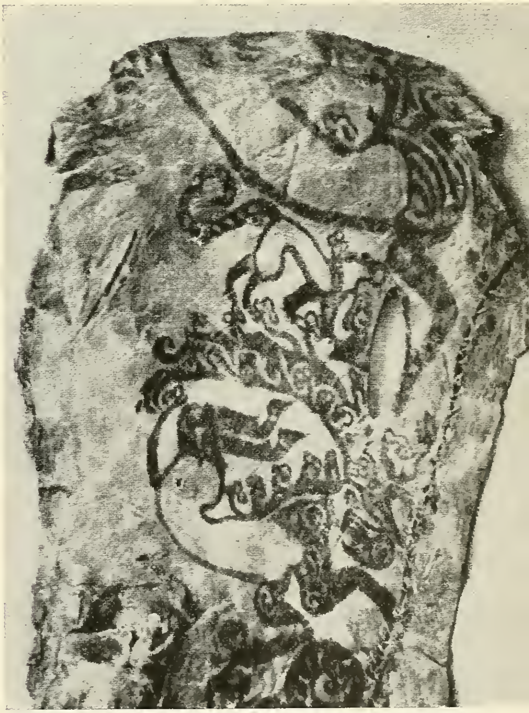
What of the Scythian gods? Most of all the Scyths rever-ced Hestia, whom they called *Tabiti*, then Zeus-*Papaeus* d his wife Ge-*Apia*. They worshiped Apollo-*Oetosyrus* d Aphrodite, calling her *Artimpasa*. Ares, for whom no ythian equivalent name is known, was the only god to om they built an altar. Only the Royal Scyths worshiped seidon, whom they called *Thamimasadas* (or *Thagimadas.)* All the tribes worshiped Herakles, from whom they imed descent, but whose Scythian name is not recorded. It is only recently, in 1950, that a Scythian town has en discovered. This was Neapolis, near Simferopol in the imea. The town is a very late one, however, not having en founded until the second century B.C., long after the yday of the Royal Scyths. We know of the latter, there-e, only from the amazing series of tombs found in South issia, the burial places of the Scythian chieftains.

Here, the Royal Scyths erected great tumuli: mounds of rth piled high above wood-lined tombs that were literally ımmed with golden relics. The nomad chieftains, to-ther with their horses, were laid at rest amid a profusion arms, armor, harness, clothing, and much gold.

When Darius invaded Scythia in the sixth century B.C., s opponent was the Scythian king, Idanthyrsus. The Scy-ian strategy of warfare was one of seeming flight, a meth- that enticed the enemy to follow until his lines of mmunication were stretched to the extreme—then the yths would turn and give battle. This angered Darius d he sent a herald to ask that the Scyths fight like men. The King's reply to Darius' taunt was couched in terms of such impudence and proud defiance that his form of expression became known to the Greeks as the "Scythian mode of speech." Idanthyrsus said, among other things: "If, however, you must needs come to blows with us speedily . . . there are the tombs of our fathers. Seek them out, and attempt to meddle with them. Then you shall see whether or not we will fight. . . ."

From this comment (the translation is Rawlinson's), the Scythians seem to have venerated their ancestors' tombs with a passionate intensity. One is tempted to attribute this veneration to concepts they brought with them from Asia: the similarity with the Chinese is evident.

HOWEVER this may be, the reverence the Scythians felt for their ancestral resting places is expressed beyond contention in the extravagant display of wealth found in the tombs. Graves as far west as Hungary have been found to contain the same opulence in golden treasure associated with the tombs in South Russia. Herodotus gave a lengthy description of the bloody funeral rites of the Royal Scythians and, while no single tomb has yet been found that would bear out his account, a combination of several of them would prove him to have been substantially correct. Every Scythian grave to be excavated had previously been plundered. Yet enough wealth has remained to show that the Scythians had a breath-taking sense of imagery and an artistic style for which the rather terse historical accounts we possess leave us almost totally unprepared.



WELL-PRESERVED DETAIL of tattoo shows similarity of these designs to the "animal" style characteristic of Scythian art.

An orientalist and historian, MR. HASKINS teaches in the Department of Art and Archeology at Columbia University. MR. GUGGENHEIM, whose travels have taken him to much of Asia, often illustrates articles for NATURAL HISTORY.

THE main art form — and the objects that gave the whole tradition its name, the "animal style"—consists of a series of representations of animals. Some are extremely realistic, others are fantastic creations. Some are twisted or contorted into improbable postures, others are fighting with an almost terrifying savagery. Some crouch in the last agonies of death, others are depicted in flight.

Among the booty of the tombs is a series of plaques of solid, cast gold, several measuring more than a foot in length and quite thick. By far the most famous of these are the gold stag (seventh to sixth centuries B.C.) from Kostromskaya Stanitza in the Kuban, and the gold feline from Kelermes, in the same general region and about the same date. It is thought that these plaques were used as decorations, or bosses, on iron shields. Indeed, the Kostromskaya stag was discovered lying atop the decayed remnants of such armor by Nicholas Veselovskii when he opened the tomb there nearly half a century ago.

This finding, in turn, has led to a great deal of speculation on the part of scholars interested in totemism. It was thought that certain animals—the stag, the feline, and perhaps the horse—were clan insignia, or even badges of rank. It is perhaps too early yet to speak of a Scythian clan of the "Stag" or of the "Leopard," but something of this nature may well have been intended by each such golden beast.

THE most complete Scythian tomb yet found—near Chertomlyk, along the left bank of the Dnieper River—was opened by Ivan Zabelin a century ago. We have already mentioned the large electrum vase from Chertomlyk: this was but one of the many splendid treasures in gold and silver that had accompanied the chieftain, his consort, and his ten horses to the afterworld. In addition to these objects of precious metal, some fine examples of Greek export-ware enabled the excavators to date the tomb toward the close of the fifth or the beginning of the fourth centuries B.C.

Chertomlyk, too, had attracted the activity of looters: the extent of the loss is impossible to gauge. But when the archeologists reopened the chamber, some two thousand years after its construction, they found that a fall of earth had trapped one ancient thief in the passageway: his bones were moldering beside the dead he had come to rob.

Chertomlyk is one of the most complex of the Scythian graves. It consists of a large, central chamber with four smaller chambers radiating from it. One of these contained the bones of the mistress of the royal grave: the remaining three chambers were presumably for courtiers or servants. The chieftain lay in solitary splendor in a bronze coffin on a wooden bed in the central chamber. While most of the wood, leather, and cloth had disintegrated, traces of clothing and carpeting were found, and a number of hooks had been provided—perhaps to support wall hangings.

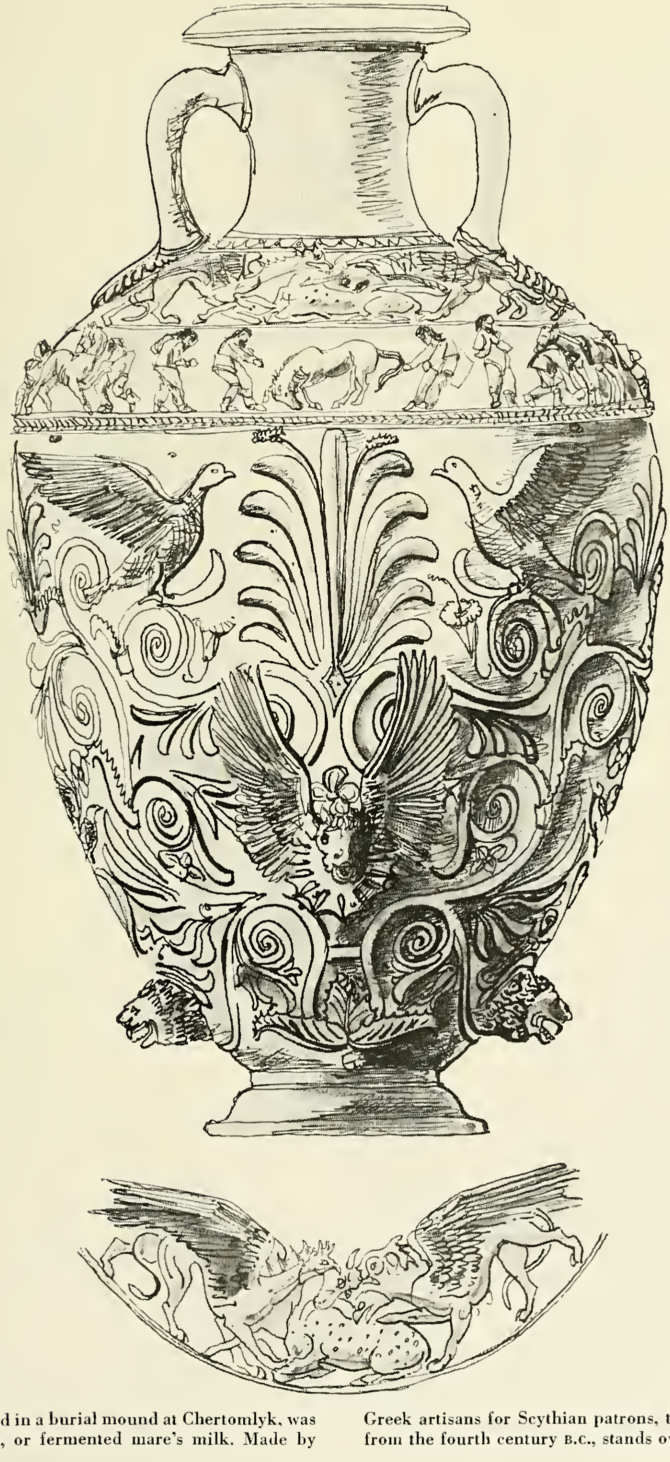
One of the most completely detailed accounts of Eurasian nomadic life comes from a region that is not truly Scythian. Near the small village of Pazyryk, in the Altai Mountains of southern Siberia, are the "princely graves," first discovered in 1928 by Sergei Rudenko and Michael Griaznov —very near the source of the gold objects that so fired the
imagination of Peter the Great. A curious combinati
circumstances has preserved the tombs of the Pazyryk
ley, and others nearby, in almost perfect condition.

Unlike the tombs of South Russia, buried in the
warmed earth of the steppes, these interments were i
mountains. Like the others, they had been plunderec
the entryways dug by the looters provided access for w
which flowed into the tombs. In the first winter there
the water froze, sheathing the contents of the graves in
ice. The Siberian tombs, moreover, were covered
rocks, instead of earth—as was the case in South Rus
and these stones reflected the sun's rays, preventing
warmth from entering the icy chambers. Thus, for
thousand years or more, the graves of the nomadic kn
in this Siberian mountain valley were kept frozen.
corpses, their clothing, the bodies of their many ho
and all their magnificent trappings—even their house
goods and vehicles—were but recently discovered, an
they were preserved in perfect condition.

WE are not as yet sure of the ethnic associations o
Pazyryk people, but they may well have bee
Massagetae of Herodotus' description. The positio
women among the Massagetae reportedly was a very
one. We are explicitly told that they were led in battle
queen. Otherwise, their customs and dress seem to
been much the same as the Royal Scyths of the West.
has led some scholars to coin the term: "kindred Scy

The construction of the Pazyryk tombs gives ampl
dence that their builders had great skill in carpentry
logs that lined the chambers, forming a sort of log
within the tomb, were each marked to indicate the
tended position—not unlike today's "pre-fab." It s
quite possible that the ingenious tombs of the high
which date from the fifth to the third centuries B.C., r
sented a sort of Siberian Valhalla—to which the bod
the chieftains were returned for burial—for it is un
that the Altai ranges could have supported even a nor
population. It may be that the graves are in the ori
homeland of the Massagetae, or that the mountains
regarded as holy places because of the gold that was n
nearby. We are told by Aristeas of the "one-eyed" *Arir*
—perhaps the *Ting-ling* (lonely ones) of the Ch
sources—who "fought the gold-gathering Griffon" i
Siberian highlands for possession of the treasure the

Scythian splendor in the West came to an end in the
dle of the fourth century B.C. The Royal Scyths succu
to the Sarmatians, a related tribe of Iranian nomads, j
the Cimmerians had broken before the onslaught o
Royal Scyths themselves, centuries before. They sur
the Sarmatian conquest and continued to live in thei
territories as long as Rome had any power in the Eas
they became Hellenized and moved into the towns,
again to reach the heights they once had known.
traded with the Greeks for wheat from the Ukraine
their later tombs, though of elaborate stone architec
are but a vague reflection of the glory that was *Sc*
Major, ". . . when," as Herodotus solemnly rec
"Targitaus, a son of Zeus, begat three sons: Leipo
Arpoxais, and Colaxais, and founded the race of Scyth
. . ." The best light cavalry the world had yet known e
its career in mercenary services with the Roman leg
During the early days of the Byzantine Empire, the
mighty Scythians wordlessly disappeared from his



LECTRUM VASE, found in a burial mound at Chertomlyk, was sed to hold kumiss, or fermented mare's milk. Made by Greek artisans for Scythian patrons, the ornate vessel dates from the fourth century B.C., stands over two feet in height.

Fossil Bonanza

ere is preserved the record of Europe's Eocene tropics

By GEORG ZAPPLER

THE SCIENCE OF PALEONTOLOGY rests on two principal ideas. The first is that. in view of the fact that sedi- ents are being deposited continuously. underlying strata when undisturbed—are older than the formations above em. The second is that a close similarity between the aracteristic assemblages of fossils found in different rock ata—however geographically remote these may be—is idence of rough, chronological identity between such rmations. These two concepts permit both the relative ting of consecutive rock layers and the correlation of atially separated deposits. Thus it is possible for the leontologist not only to establish the chronology of pro- essive. evolutionary changes within a particular line of imals or plants, but also to envision the general environ- ental picture at various places on the earth's surface ring particular periods in geological history.

Such attempts to reconstruct past ecological situations, course, face many difficulties. Only rarely is enough ssil material preserved in any given locality to permit lid inferences about *all* the geological, climatic. and bio- gical factors acting at the time of deposition. Occasion- y, however, due to particularly fortunate circumstances, collection of fossils is made. which—when studied in lation to all the structural features of the site—yields an nazingly detailed panorama of the past.

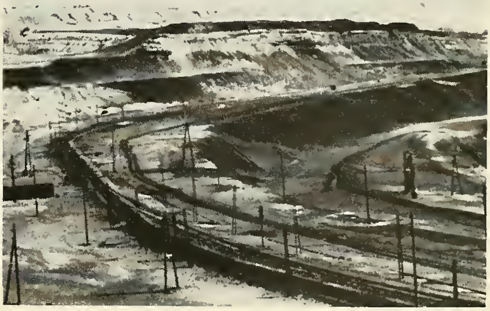
One such find occurred in the 1920's in middle Germany. cavations and studies that began then were continued to World War II: recently, work has started again and w material is being turned up each season. This paleon- logical bonanza is the Geisel Valley, a long-established nite (brown coal) mining area. west of Leipzig. It has en possible to date these lignite deposits by comparing me of the fossils they contain with similar species—ecially certain fresh-water snails—found in formations established age. The Geisel Valley fauna and flora have us been assigned to the middle Eocene epoch—some forty- e million years ago, soon after the beginning of the nozoic era. and roughly twenty-five million years after e extinction of the dinosaurs.

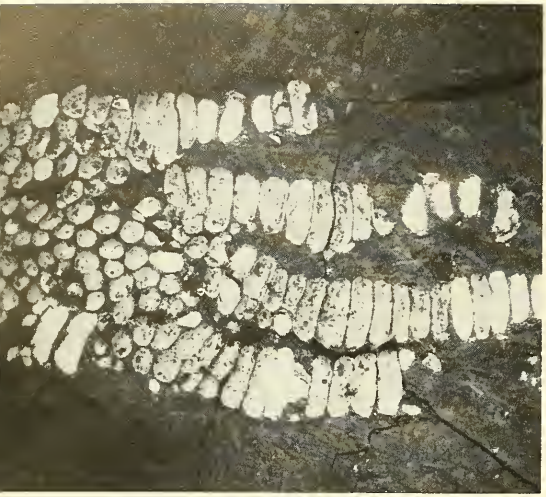
The Eocene follows upon the Paleocene epoch, the first vision of Cenozoic times, and represents a critical period the evolution of post-Mesozoic faunas. Through most of e Mesozoic era, the mammals had been evolving in the adow. so to speak. of the then dominant reptiles. With e extinction of most of the latter. mammals were able to dergo their first major adaptive radiation. Many en- onmental opportunities had been vacated as a result of e still little-understood mass death of the ruling reptiles of land, air, and sea. In consequence, the mammals—generally small, relatively insignificant and largely insectivorous during the Mesozoic—were free to evolve in many directions. A whole spectrum of ecological "jobs" was now open and there arose, to fill these niches, a variety of new mammalian forms—ponderous herbivores. sharp-fanged carnivores. gnawing rodents. and tree-dwelling primates on the land; bats to fill the air; porpoises and whales to seek a living in the seas, and many others. Thus the Paleocene and first half of the Eocene mark the initial appearance of most of the major groupings of mammals.

MANY of the representatives of this first adaptive radiation of the mammals were "failures" from a retrospective point of view. That is, they themselves did not give rise to the modern mammals of later epochs. Instead, some of their initially less important and comparatively unspecialized relatives became the actual ancestors of the successful mammals of later Cenozoic times. Although the archaic, Paleocene mammalian fauna continued to survive into the Eocene. by the end of that epoch the representatives of this replacement radiation had become firmly established. Thus. middle Eocene times mark a period of transition between these earlier animals and the ancestors of modern mammals. As will be seen. the Geisel Valley finds show this mixture of "old" and "new" very clearly.

From what is known of the history of world climates in general, the warm, equable conditions apparently characteristic throughout the world in Mesozoic times graded imperceptibly over millions of years into the sharply delineated climatic zones and seasons of today. The early Cenozoic period was marked by essentially unchanged, tropical to subtropical environments carrying over from

CENE BEETLE, *left,* preserved in the brown coal beds of e Geisel Valley, still shows an iridescent trace of its iginal color. At right is a view of the fossil-rich mine.





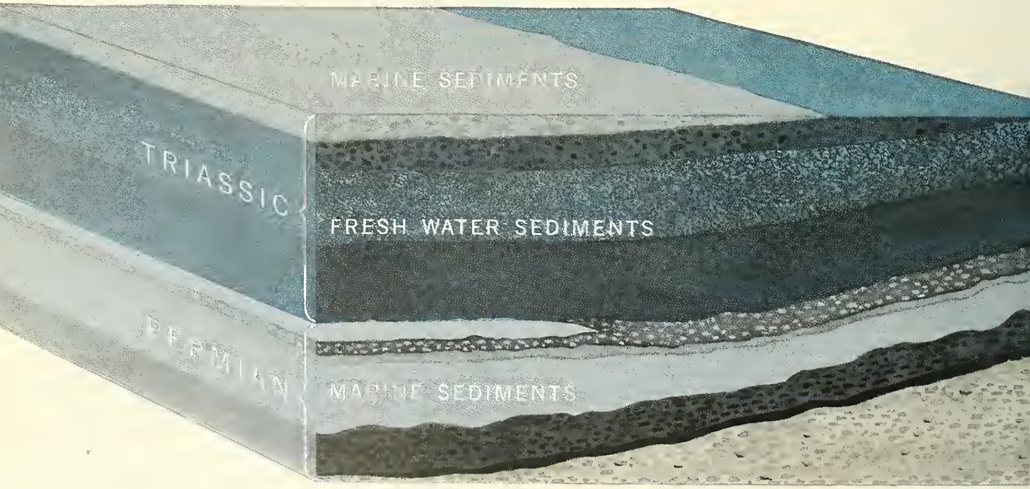
Example of preservation is this nearly perfect lizard's "glove"—skin shed from animal's paw during Eocene times.

the Age of Reptiles. It was only later that arctic, temperate, and equatorial belts gradually became established, culminating in the Ice Age of Pleistocene times, roughly a million years ago. Hand in hand with these climatic changes, and no doubt causally related, was a marked tendency to continental uplift. This trend had already started toward the end of the Mesozoic. Throughout the next era—the Cenozoic—the inland seas retreated and our familiar mountain systems were born. The Alps and Himalayas of the Old World, and the Rockies and Andes of the New were rearing their first peaks by the beginning of the Cenozoic, to be worn down and raised up
several times in the course of later epochs.

As for vegetation, the flowering plants and deci
trees of modern times began to put in their appea
toward the end of the Mesozoic—and the new flora re
the former forests of tree ferns, horsetails, club m
and primitive conifers such as ginkgoes and cycads
extensive spread of temperate grasslands and pra
which provided new habitats for many mammals—d
occur to any degree until mid-Cenozoic times, when
climates were definitely becoming more sharply zone
tropical conditions becoming restricted to the belt
the Equator. Before then—that is, during the Paleocen
Eocene—damp, hot jungles covered most of the ear

From early Cenozoic times on, continental outlines
ably looked much as they do today. Europe was an
tion. Through most of the Cenozoic, Europe seems t
been an area widely traversed by shallow arms of t
and consisting of a number of large islands rather
an unbroken, extended land surface. While the exa
lineation of previous shore lines is not of too much
quence, the question of connections between contine
of tremendous interest to the zoogeographer, if he
to understand the distribution and evolution of Ce
faunas. The existence or non-existence of "bridges,"
ing or severing the major land areas, has played an
mous role in the establishment of similarities and
ences among animals in various parts of the world.

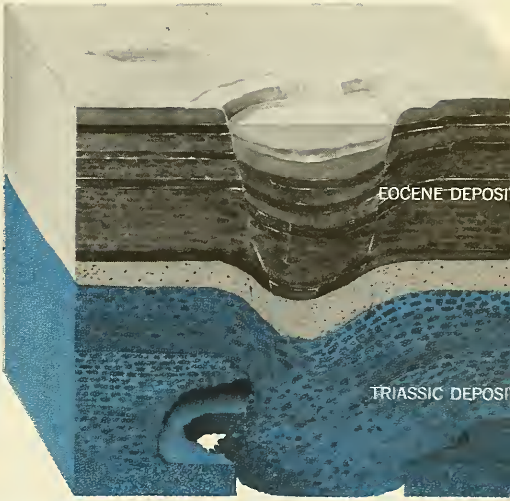
It is a paleontological fact that, throughout Ce
times, the greatest resemblances are to be found a
animals distributed through the great circumpolar
represented by North America, northern Asia, and E
If we look at a map of the world today, it is apparen
the Bering Strait region offers the best possible
toward an explanation of this phenomenon. Most scie
feel that a passage of dry land existed between Alask



Geisel Valley region is shown, *above*, in reconstruction of conditions before Eocene coal formation began. Under the thick layers of Triassic, fresh-water sediment
marine deposit of salt, 300 meters deep, of Permian

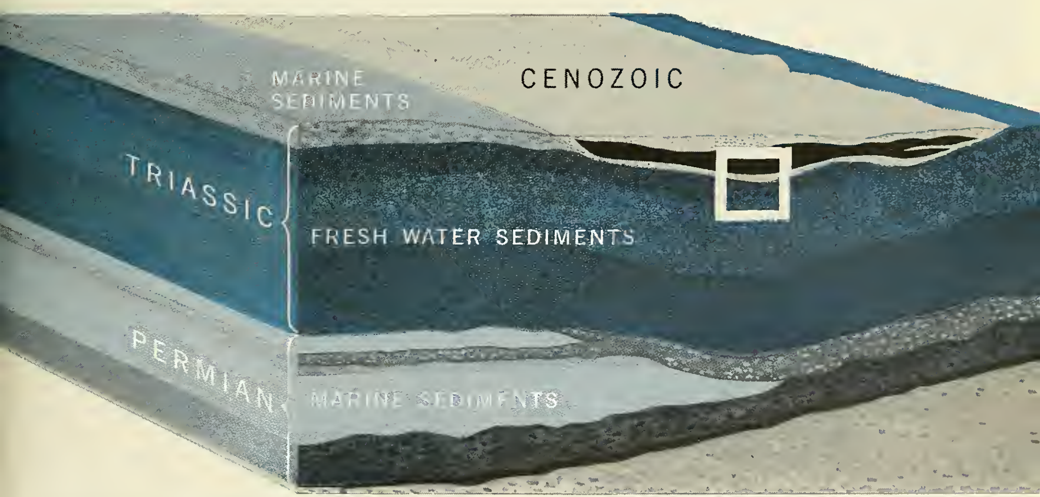
northeast Asia across which animals could move in either direction—this connection probably becoming severed and re-established several times in the course of the Cenozoic. Usually, then, North America, Europe, and northern Asia are considered a single zoogeographic region, within which differences certainly exist (to varying degrees at different geologic times), but where the over-all similitude of faunal assemblages is generally quite marked.

Southeast Asia is frequently designated a separate zoogeographic area, but the distinctness of this, the so-called Oriental Region, is of relatively recent origin, mainly owing to climatic zonation during late Cenozoic times, and partly to the barrier to free interchange provided by the Himalayan mountain range. Africa, too, has been named as a separate faunal realm. However, extensive land connections—restricted presently to the Suez isthmus—have usually existed between southern Europe and Africa, as well as between southern Asia and the Dark Continent, through most of the Cenozoic. The uniqueness of much of the African fauna today is primarily a result of its animals having become extinct in the more northern regions of the Old and New World only a short time ago. In many respects, then, North America, Asia, Europe, and Africa can be considered to have formed a conjoined land mass (with occasional breaks) through most of the Cenozoic, particularly during the early epochs—Paleocene and Eocene.

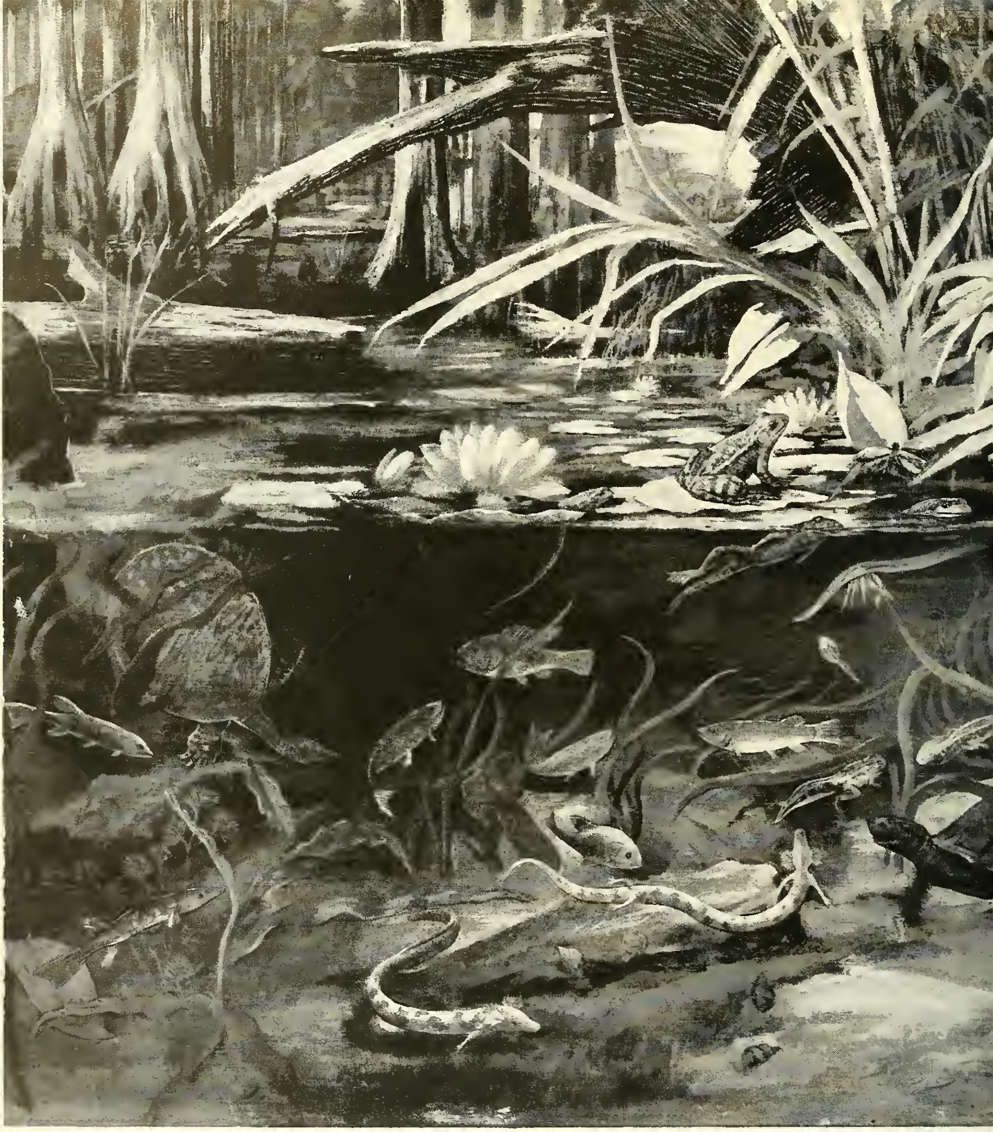


Detail of diagram, *below,* shows how funnel "traps" were formed on surface by leaching of gypsum in strata below.

How do the Geisel Valley discoveries fit into this picture of early Cenozoic conditions? What series of events led to a rich fossil locality in the midst of the lignite fields of middle Germany? The presence of vertebrate and invertebrate fossils in lignite beds is, in itself, unusual: the humic acid given off during the decay of vegetable matter—these plant remains, themselves, providing the raw material for the formation of coal—usually destroys all animal bone and tissue. However, during the deposition of the Geisel Valley coal beds, calcium-rich springs—seeping upward from neighboring calcium carbonate rock strata—were able to neutralize the normally destructive acids. In addition, calcium salts were being brought in by the streams that fed the low-lying marshes. These circumstances brought about a type of fossilization almost unique in the annals of paleontology. Not only have thousands of fossilized bones been located but, very frequently, the soft parts of the animals have also been preserved in the lignite. Often, indeed, the bones are gone but the soft tissue remains. Thus, for example, the intact brains and spinal cords of frogs (that were otherwise completely disinte-



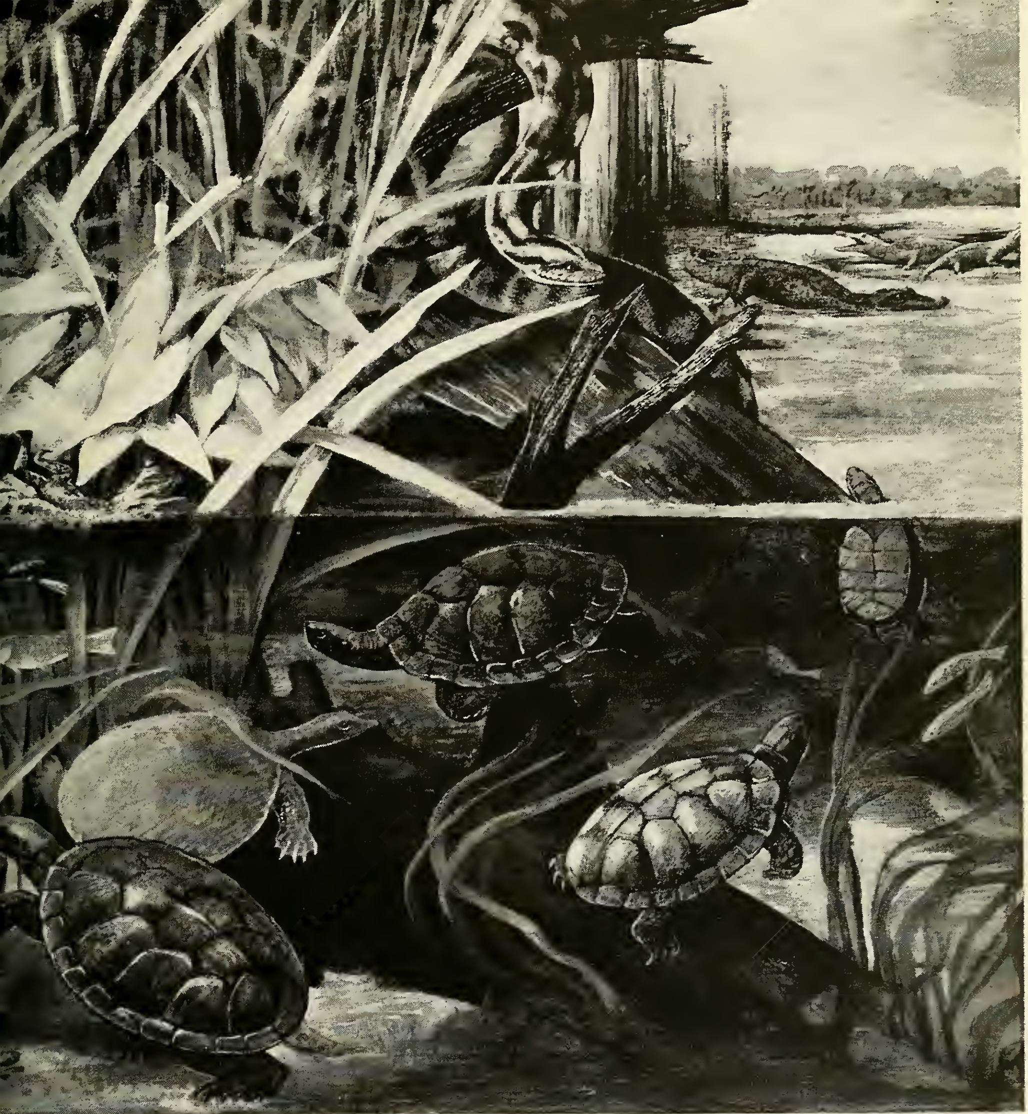
Valley region today is marked by central depression that was caused by subsidence of Triassic strata as underground water leached away most of Permian salt beneath. Decaying plant life of Eocene times filled hollow, turned to lignite.



Geisel Valley swamps, in Eocene times, were inhabite
wide variety of lower vertebrates. In this reconstruct

grated) have been found—the nerve substance converted from its original consistency into calcium compounds of fatty acids. The muscle tissue of beetles, fishes, frogs, salamanders, lizards, and mammals has been clearly identified. Cartilaginous and connective tissue finds have also occurred. Perhaps the most striking case is an instance in which the outermost layer of a frog's skin is so perfectly preserved that individual cells, with their nuclei still intact, can be made out distinctly. It has even been possible to make microphotographs of fossilized red blood cells and to analyze the actual stomach contents of various animals. Preserved feathers and fur scraps are not unusual. Often, animal and plant pigments (chlorophyll, for example) can still be identified chemically. Many of the beetles, when
uncovered, reveal themselves in their original gaudy
oration, with their outermost chitinous covering unharm

Starting in 1926, Johann Weigelt, a German geolo
and paleontologist, together with a group of talented s
ialists, set himself the task of carefully relating all this m
rial to the enclosing geologic structure and sedimentat
of the Geisel Valley in an effort to determine the conditi
under which these animals of the middle Eocene had li
and died. By making careful three-dimensional maps
the excavations progressed, it was possible to deline
exactly the spatial relationships of the fossil finds to

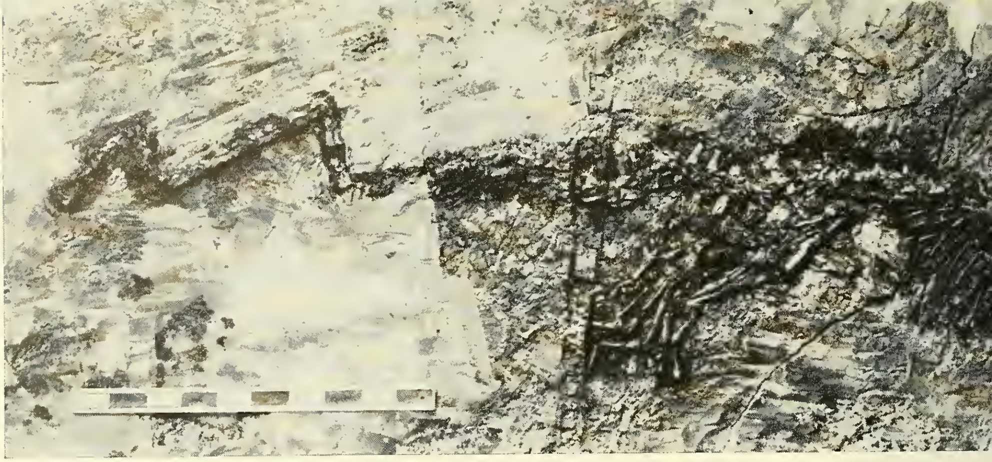


are shown fishes, salamanders, frogs, hard- and soft-shell terrapins, a constrictor at top, crocodiles in background.

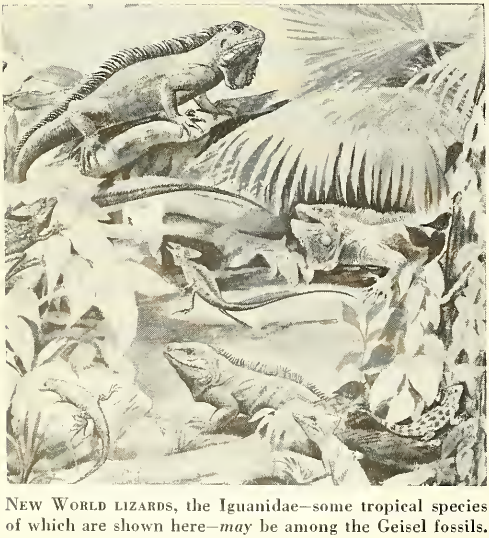
over-all stratigraphy of the coal beds and the underlying rock layers. This map work revealed that practically all the animal remains were contained either in shallow pans (from fifty to a hundred square yards in extent), in deep, funnel-like depressions, or in zones that were formerly the swampy banks of streams.

How did these shallow depressions and pits arise in the first place? It appears that subsurface waters acted on underlying layers of salt and gypsum to create subterranean caverns. Such extensive leaching of some of the deeper lying, massive salt beds within pre-Mesozoic strata (diagrams, pp. 20, 21) is what brought about the over-all sinking of the Geisel Valley region in Eocene times. The collapse of underground hollows, under the weight of accumulating plant debris, was not a uniform process. In addition to an over-all settling of the region, some areas would subside more rapidly than others—forming depressions on the surface. Sudden, localized soil-collapses—owing to cavern formation in upper levels—also occurred, thereby producing the deep funnels (diagram, p. 21).

Weigelt and his co-workers paint the following picture of how some of the Geisel Valley fauna ended up in the spots where they have been found: water, collected during periods of heavy rainfall in the swampy, depressed central



region of the valley, would retreat during dry spells. The shallow basins and deeper pits would remain as small lakes and water holes. Such bodies of water were inhabited by numerous crocodiles, as well as by fishes and other aquatic and amphibious animals. As the drought progressed, some of the shallower lakes dried out, leaving behind an accumulation of victims—land-dwellers that had been drowned during previous floods as well as the usual, aquatic inhabitants. The deep funnels were probably more or less permanent water holes. Such drinking sites are always corpse-collectors: thirsty visitors often fall prey either to the hungry saurians in the water or to other carnivores lurking on land. Then, too, since the funnels' banks were dangerously steep, accidental drowning must have been fairly common. Nor is it surprising that various animals should also have perished in the boggy soil bordering the streams they visited for water or attempted to cross.



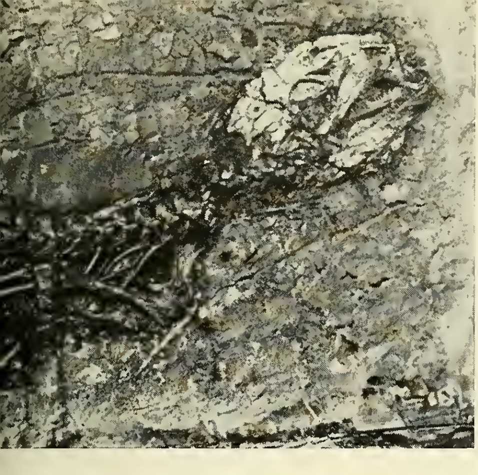
NEW WORLD LIZARDS, the Iguanidae—some tropical species of which are shown here—*may* be among the Geisel fossils.

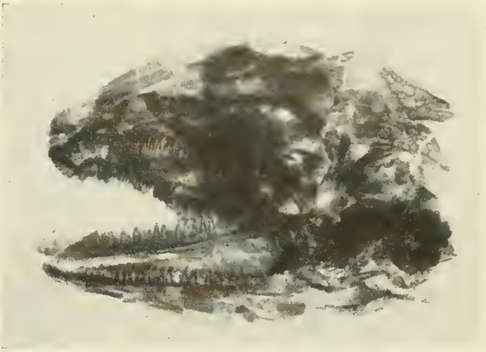
SINCE the Geisel Valley fauna occurs in a coal dep we are justified in concluding that swampy condit prevailed generally at the time of deposition. All coal c sists of carbonized plant remains, formed in poorly ve lated, or stagnant, wooded swamps that are slowly s siding. Examination of the preserved plant material o permits identification of many of the species of trees grasses involved in the formation process. In the cas the Geisel Valley deposits, the flora has been particul well preserved. A combined analysis of woody mater leaves, pollens, and seeds presents the picture of a m subtropical forest. Among the most common trees v sequoia, cypress, magnolia, palm, fig, rubber, breadf cinnamon, and mango. Lianas hung in profusion f every available branch. The small lakes and water h we have described were enclosed within this low-ly jungle. Neighboring, more elevated areas consisted of c savanna and, from the skeletal evidence, provided a h tat for ground-nesting birds and land tortoises.

Adjoining the dense jungle was an open swampl poorly drained by meandering streams. Here and th an occasional clump of oak or pine would stick out al the thick growth of rushes and other marsh plants. As the more lowly representatives of the plant kingdom—s as algae, fungi, and mosses—these, too, left records. phytic and parasitic algae have been recovered. Fu detected on the preserved cuticle of leaves, resemble recent *Penicillium* mold species. Even bacteria—counte the lowest of plants—can be identified in the eye cav of fish skulls, in portions of frog skin, in insect tissue, in various animal feces.

So much for the probable physical appearance of Geisel Valley during the middle Eocene. A look at many thousands of animal fossils that have been unear provides further details for our picture. It is appropi to point out, here, that the *relative* abundance and div fication of the various animal groups living in the G Valley some forty-five million years ago cannot be infe with accuracy on the basis of the *absolute* number representative specimens collected as fossils. Accident preservation, as well as of collection, make for a cen that must contain many omissions.

Among the invertebrates in the Geisel Valley, the r





Complete skeleton, *left*, of Old World lacertid lizard, is best early fossil of this family known. X-ray, *above*, of its skull shows remarkable detail preserved in Geisel coal.

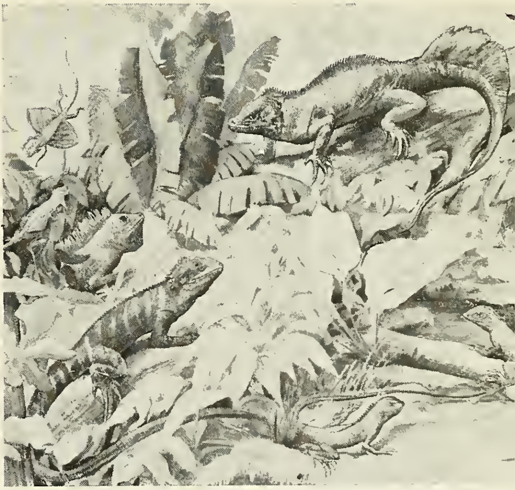
ommon forms are the beetles—many belonging to groups at still occur today in subtropical and tropical regions f the world. One most interesting find was the preserved kin of a parasitic worm: no representative of the group -the Nematomorpha, or hairworms—to which this specien belongs has ever before been found in fossil form. iving relatives of this creature, today, are all parasites f insects throughout the greater part of their life cycle.

The few mollusks that have been found are represented y land-living as well as fresh-water snails. All of them, judge from living relatives, were adapted to a warm, oist environment. Crustacean fossils are very rare—only few fragments of crayfish-like types occur.

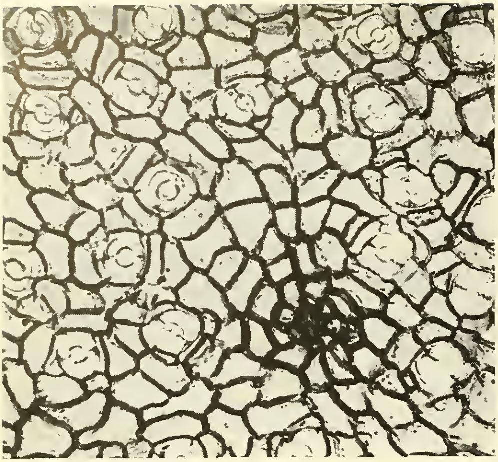
The abundant beetles were not the only insects dug up in quantity. In general, the fossil history of insects -the most highly developed class among the arthropods— s a very poor one. Insects, being mostly small flying forms, arely get preserved. We know that the class, as such, has xisted since late in the Paleozoic era, and that most of its odern orders—of which the beetles constitute one—were stablished well back in the Mesozoic. But the detailed hylogenetic history of the various insect lineages is full f gaps. It is thus of great interest to find so lavish an ssemblage of Eocene date. Besides the Geisel Valley's any different genera and species of beetles—some adapted life in the jungle, others to open swamps—the remains f termites, dragonflies, roaches, gnats, and cicadas have een identified. A few butterfly wing scales give us the arliest fossil record of this, the youngest of the insect rders. There are, in addition, fragments of May flies, tone flies, and even the cemented case of a caddis fly arva. A really remarkable instance of preservation is fforded by the presence of bluebottle fly larvae in the nose egion of one of the tapir-like lophiodonts. Apparently, he adult flies had laid their eggs in its decaying carcass: he hatched-out larvae were later preserved in every detail f their external and internal anatomy.

Among the vertebrates, every class is represented in the eisel Valley finds. Literally thousands of fish skeletons, any of them with adhering scraps of skin, muscle, and dipose tissue, have been recovered from some of the ried-up basins. Even pigment cells are often intact, and contrasting shades of color may still be observed. These fishes include rather small, primitive members of the pike, bass, and salmon groups. Mingled among them are the abundant remains of amphibians: frogs—in all stages of development from tadpole to adult—and salamanders. The frogs include members of several present-day families: various toads, and possibly even a true *Rana*, the dominant, cosmopolitan genus of modern frogs. From an analysis of preserved frog skin, still containing pigment bodies, it has been possible to conclude that these Eocene frogs were green in color. It is not surprising that frogs should have been this far "advanced" in their specialization by the early Cenozoic: the group as a whole can be traced back to the labyrinthodonts of the late Paleozoic, while the first true frog is found in early Mesozoic deposits.

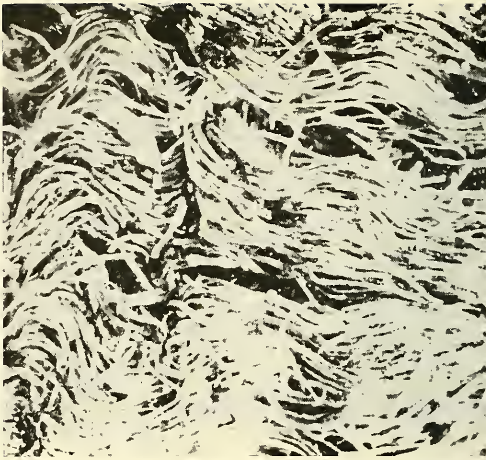
Almost all the Geisel Valley's fossil salamanders were permanently aquatic forms: that is, they did not spend



Old World lizards, the Agamidae—shown in convergent tropical species—occupy the same niches as the iguanids.



leaf cuticle (× 800)



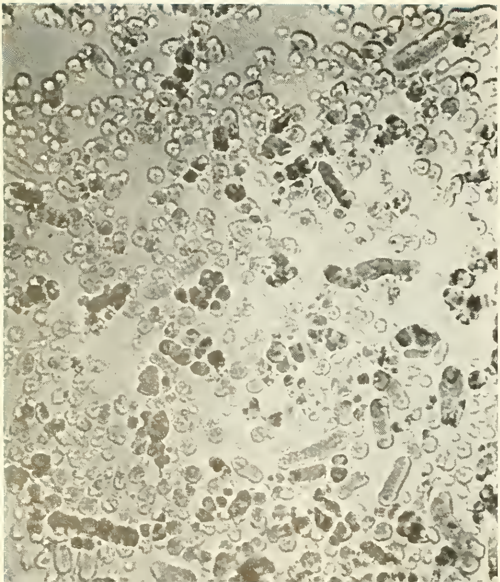
vulcanized sap (×

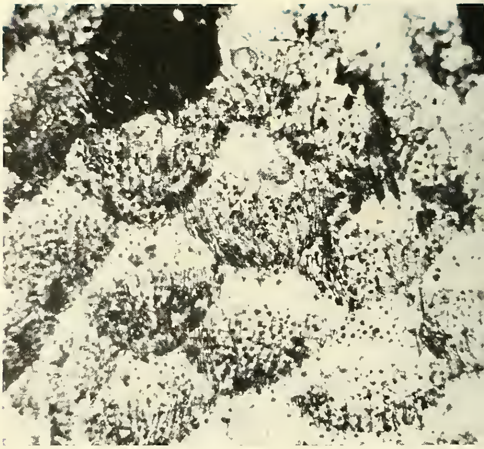
Examples of plant and animal remains that are preserved

Although the Geisel Valley fossil deposits are remarkable in a great many respects, the most striking aspect of the material from this site is the microscopic detail in which plant and animal tissue has been preserved. Such instances of soft tissue fossilization, although not unknown in paleontology, are of rare occurrence. The best-known cases are, of course, the fully fleshed and furred mammoths from the Siberian ice. There is also a record of an entire rhinoceros, from Galicia, coated with a preservative film of oil.

A few among the many striking examples from the Geisel Valley are shown on these pages. Such unique instances of preservation are caused by the unusual circumstance of calcium-rich ground and surface waters exerting a neutralizing action on the normally destructive humic acid that is given off during the plant decay attendant on coal formation—suc
these brown coal deposits.

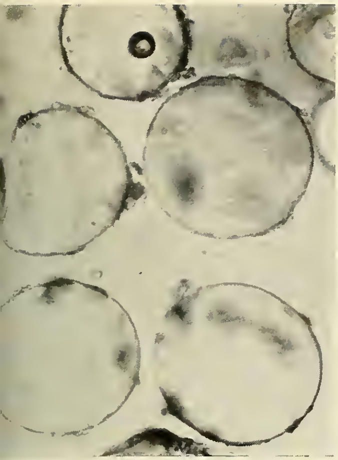
Seen at the top of these page
three plant microphotographs.
left to right. these are: (1) cells,
of them with openings called sto
for respiratory exchange, makin
the cuticle of a leaf; (2) natu
vulcanized strands of the milky
characteristic of gum tree woods;
gum droplets accumulated in the
of a rubber tree. Seen below are





fish scales (×

tissue cells (× 875)

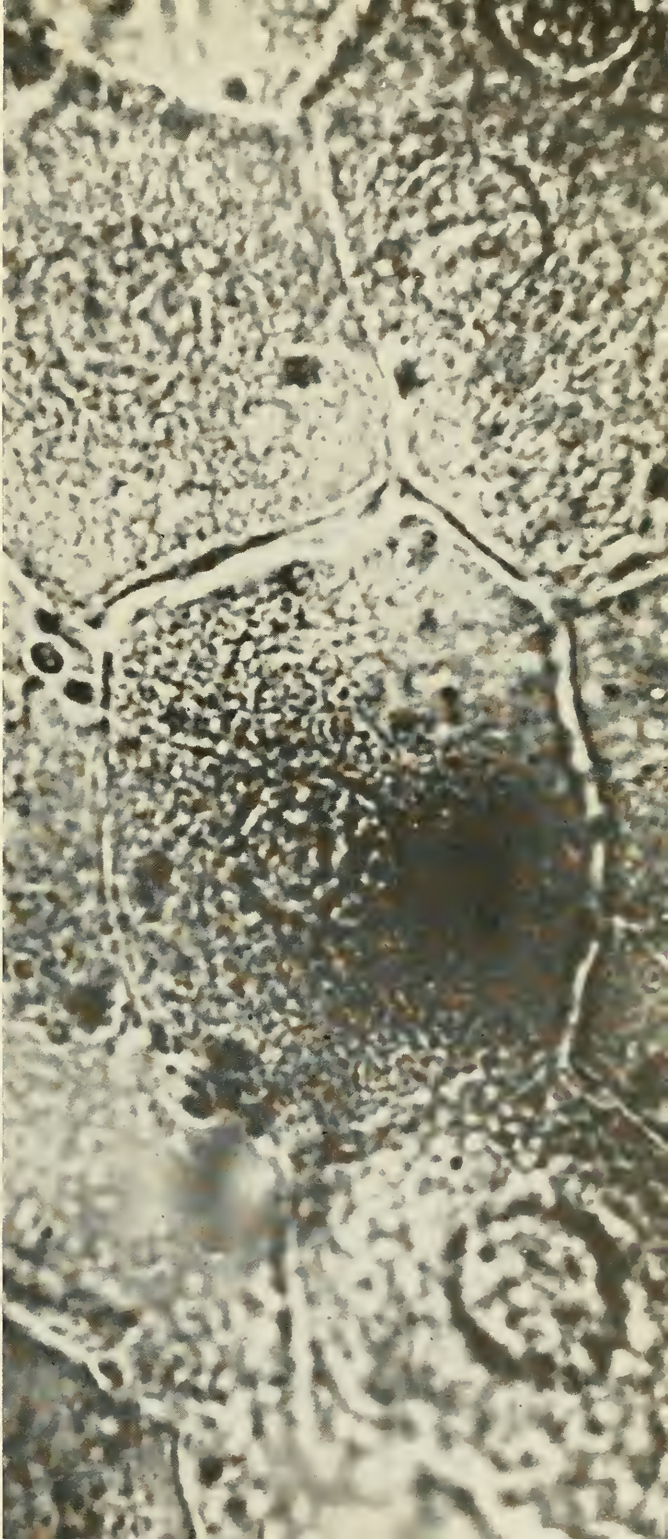


m droplets (× 800)

nicroscopic detail

xamples of preserved animal tissue. rom left to right, there are (1) crocdilian connective tissue cells; (2) ales and pigment cells from the skin ' a fish; (3) enlarged bird feathers und adhering to isolated bones. inally, the microphotograph on the ght gives us an example of extraornary fossilization: frog epithelial ssue, showing the separate cells so ell preserved that even their individl nuclei are easily distinguishable.

eathers (× 50)



cells and nuclei (× 4600)

their adult existence on land. Normally, the cartilaginous structures that support the external gills of the almost always aquatic larvae become much reduced and highly modified in the lung-breathing adults. Sometimes, however, complete metamorphosis does not occur: then, the sexually mature individuals, retaining their gills with now largely ossified gill-arches, never leave the water. Over two hundred specimens of such a non-metamorphosing species have been found, with clearly recognizable, bony gill supports. Being dependent on a watery environment for oxygen, they were trapped—as were the fish—when the periodic droughts occurred.

There lives today in the caves of southern Europe (the Adriatic regions of Italy and Yugoslavia) a peculiar, elongated, pigmentless, permanently gilled, blind, cave salamander (*Proteus*) whose phylogenetic position has long been debated. The Geisel Valley form just described (called *Palaeoproteus*) appears to be a direct ancestor of this blind European *olm*; still somewhat shorter, with functional eyes and with a full complement of toes and fingers (instead of the reduced number possessed by its descendant), but otherwise very similar anatomically.

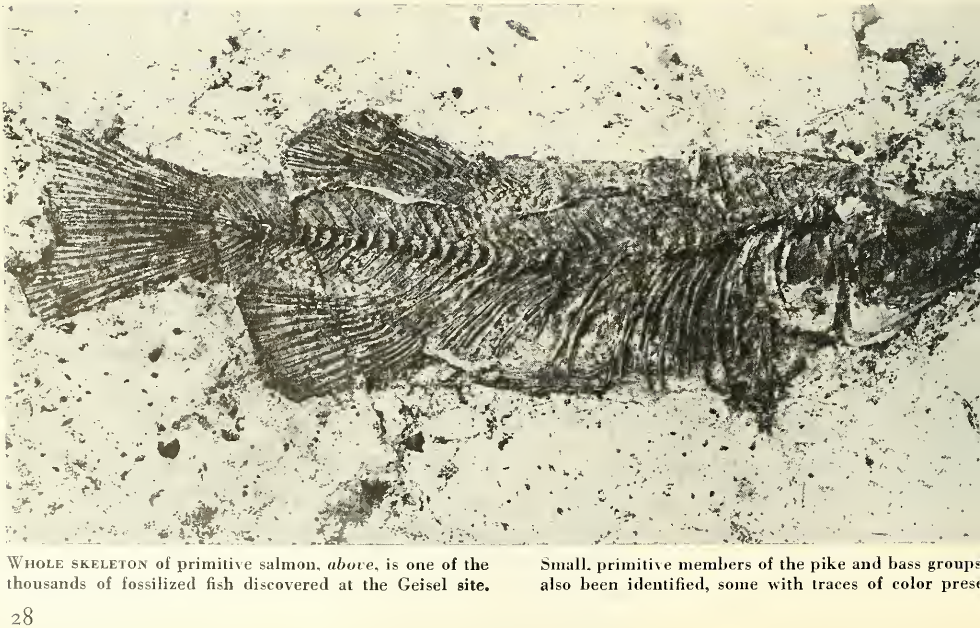
Among the few more typical urodeles, one identifiable primitive genus (*Tylototriton*) has living representatives in eastern Asia, and is considered to be close to the ancestral stock of the common salamandrids.

The Geisel Valley collection includes many reptiles—members of the main stocks that had successfully weathered the mass extinctions at the end of the Mesozoic—squamates (including both snakes and lizards), turtles, and crocodilians. Primitive boids (the snake family that includes boas and pythons), some of them small enough to have just hatched, have been found. Snakes are believed to have evolved from a burrowing lizard group, and the boids are among the earliest representatives. They first appear toward the end of the Mesozoic and—while all the various limb elements have disappeared in most snak the boids still retain some vestiges of the rear legs. and pythons have always been world-wide in their di bution, although now restricted mainly to the tropic North and South America, Africa, Asia, and Australi

TRUE lizards are known from the early to middle zoic onward: the Geisel Valley has yielded thei mains by the hundreds. Among them were several r bers of the anguid family, a group that presently incl the alligator lizards of the western United States, galliwasps of Central and South America—both four-le forms—the "glass snakes" of Asia, southeastern Eu and North America, and the "slowworm" of Europe last two being secondarily limbless. The Geisel V "glass snakes" are the earliest recorded representativ this group, which has always been and remains to day an essentially Eurasian assemblage, never penetra into the tropics of either Asia or Africa, although a forms reached North America fairly late in the Cenc Other fossils belonging to this family include some r bers of the same genera of anguids known from then temporary Mongolian and North American deposits placosaurs—fairly large, heavily armored, limbed li that later became extinct in the Old World, surviving in the Western Hemisphere.

The single lacertid lizard found during the excava is of great interest since it marks the earliest well ic fiable member of this strictly Old World family of ty and relatively unspecialized lizards. The lacertids common all through Europe, Africa, and Asia, but have never reached the Philippines or Australia.

Among the many fragmentary lizard bones that been described, several have been assigned, if some doubtfully, to the iguanid family. Such identification interesting zoogeographical implications: the iguanid



WHOLE SKELETON of primitive salmon, *above*, is one of the thousands of fossilized fish discovered at the Geisel site.

Small, primitive members of the pike and bass groups also been identified, some with traces of color prese now, and appear to have been, possibly since the end of the Mesozoic, more definitely since the middle Cenozoic, essentially New World in distribution—with two peculiarly farflung "outposts," one in Madagascar and the other in the Fiji Islands. In the Old World, except for Madagascar, the place of the iguanids is taken by the agamids, which are particularly widely distributed hroughout the tropics of Africa, Asia, Indonesia, and Australia (the more temperate regions of Europe and northern Asia being occupied mainly by lacertids). Anaomically, the two groups are quite similar, except that he agamids have teeth located on the crests of the jawbones, whereas the iguanids' are set on the inner sides of he jaws. Both families are therefore considered to have shared a common ancestry at one time in their evolution. For practically every specialization developed by an Old World agamid, there exists a counterpart among the guanids of the New: both groups have burrowing, arboreal, and semiaquatic as well as strictly terrestrial representatives, which sometimes strikingly converge toward each other in appearance (illustrations, pp. 24, 25). Herpetologists have long attempted to account for the complementary distribution of the two families—but the fossil record is too spotty to fill in any satisfactory historical background. This incidence of iguanids from the middle Eocene of Europe, if substantiated, would indicate a former Old as well as New World distribution for the group. Additional evidence for such a conclusion is provided by ate Eocene lizards from Mongolia that resemble iguanids n their tooth emplacement.

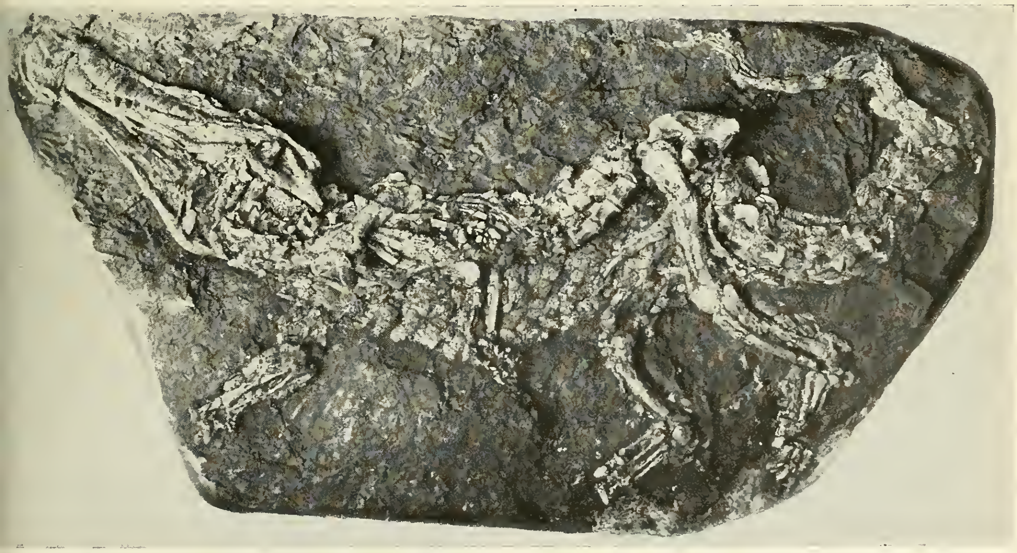
Aside from these insights shed on former distributions, he Geisel Valley fauna demonstrates clearly that all the ecological niches occupied by present-day lizards were already taken up by then living types. There were longailed, agile tree-climbing lizards; sturdy terrestrial forms, many of these heavily armored; and burrowing lizards, some almost legless and some completely without limbs. Interestingly enough, several cases of autoamputation of the tail, with later regeneration, can be established.

Softs parts of lizards include fragments of skin, in one case a clearly recognizable "glove," peeled from the hand at the time of shedding—the process of discarding the outermost layer of dead skin. Musculature traversed by vessels filled with demonstrable red blood cells is still attached to some of the lizard bones.

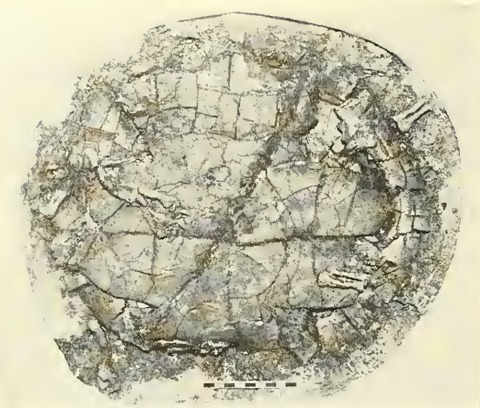
Turtles, most of them fresh-water terrapins, have been excavated in considerable numbers. Many modern species of turtles go into a state of dormancy on the bottom of pools during inclement weather conditions. Possibly the dense distribution and undisturbed condition of many of these fossil terrapins, lined up side by side in shallow depressions, can be attributed to death having overtaken them while so estivating. Only one land tortoise—possibly an inhabitant of the nearby savannas, washed down during some flood—has so far been discovered.

The order of turtles, the Chelonia, can claim direct descent from the late Paleozoic stem reptiles, and they have constituted a successful, but very conservative, group since early Mesozoic times. The single land tortoise reported from the Geisel Valley represents one of the earliest recorded members of the testudinids—the world-wide family (with the exception of the Australasian region), which includes most of the slow-moving, mainly ground-dwelling types among this ancient order.

AMONG the fresh-water forms discovered, soft-shelled turtles (or those without shells or with greatly reduced scutes over their shells) were relatively rare. There were fragments of several true soft-shells, the trionychids, of the genus *Trionyx*. Trionychids have had a complex history in North America and the main continents of the Old World since late Mesozoic times, but have never reached

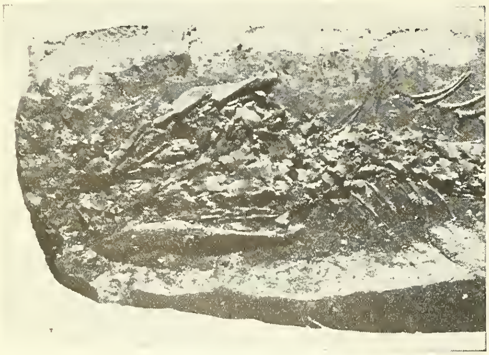


WHOLE SKELETON of crocodile is another example of ideal quality of the Valley's fossil finds. The short, flattened toe segments of this specimen suggest its possession of small hoofs—and thus a more terrestrial way of life than usual.



LAND TURTLE, the only one found thus far at site, is seen from underside, *above*. It is one of the earliest testudinids.

FOSSIL FROG, *above*, has been identified as a member of a now extinct family of toads, known as the Paleobatrachidae.



SNAKE SKULL, *above*, is that of a small boid, the primitive constrictors that evolved long before venomous snakes did.

MR. ZAPPLER, a regular contributor to these pages, wo honorable mention in 1959's AAAS-Westinghouse Scien Writing Award. H.-W. MATTHES and G. KRUMBIEGEL, the Geisel Valley Museum, kindly provided illustration

South America. Today, they inhabit eastern North A ica, southern and eastern Asia, and Africa. Most of remainder of the Geisel Valley terrapins were mem of the genus *Geoemyda*, found today in the forests streams of southeastern Asia and tropical America.

Recent soft-shells are inhabitants of swiftly flo streams. To judge, then, from the scarcity of such t remains in the Geisel Valley, the rivulets there were p ably of a slow-moving nature and floods would acc for a few specimens washed in from outlying river syst

CROCODILIANS must have been a very populous g in the region. They were mostly alligator-like, stubby snouts and with limbs well adapted to swimm Many of their eggs, sometimes with embryonic struct still visible, have been unearthed. The preserved fece these animals are generously distributed over most o valley's fossil-bearing beds, and some of these copro can be analyzed for animal pigments as well as for terial content. Gizzard stones, such as are still posse by present-day crocodilians as an artificial aid in grinding-up of food, are often found in place.

The closest living relatives of the extinct dinosaurs crocodilians have survived their once dominant con to inhabit all the subtropical to tropical regions of world today. The order is known from mid-Mesozoic t onward, the modern or "advanced" crocodilians as appearing in the late Mesozoic. The principal recent ilies are the crocodiles, world-wide in their occurre the alligators, located mainly in the Western Hemispl but with one representative in China; and the gavials, found only in India. During the early Cenozoic, the two families were still in the process of divergence can be observed from the Geisel Valley fossils, the tinction between alligators and crocodiles, clear cut to was not nearly so sharp at that time. All of the specir were very heavily armored, more so than modern fo with bony plates underlying the skin of the back undersides. One interesting discovery was a crocodile type with expanded terminal toes—as though it had sessed small hoofs. Conceivably this was an adapta for a more terrestrial way of life than is usual for cr dilians. Its whiplike tail, in contrast to the rudder structure of aquatic forms, lends weight to this conclus

The Geisel Valley fauna is unique in the variety o preserved amphibian and reptilian material. Altho these lower vertebrate classes, as a whole, had long s been replaced by the warm-blooded, higher vertebrat the birds and the mammals—great interest still cer around the evolution of these once-dominant groups today's frogs, salamanders, lizards, snakes, turtles, crocodiles. The middle Eocene record provided by the sils of the Geisel Valley has and will continue to s light on this intriguing aspect of vertebrate paleontol

(*To be concluded in November*)

FOSSIL ALGA of Eocene date, *right*, was found attache a fossilized leaf. Here, it is seen at magnification x

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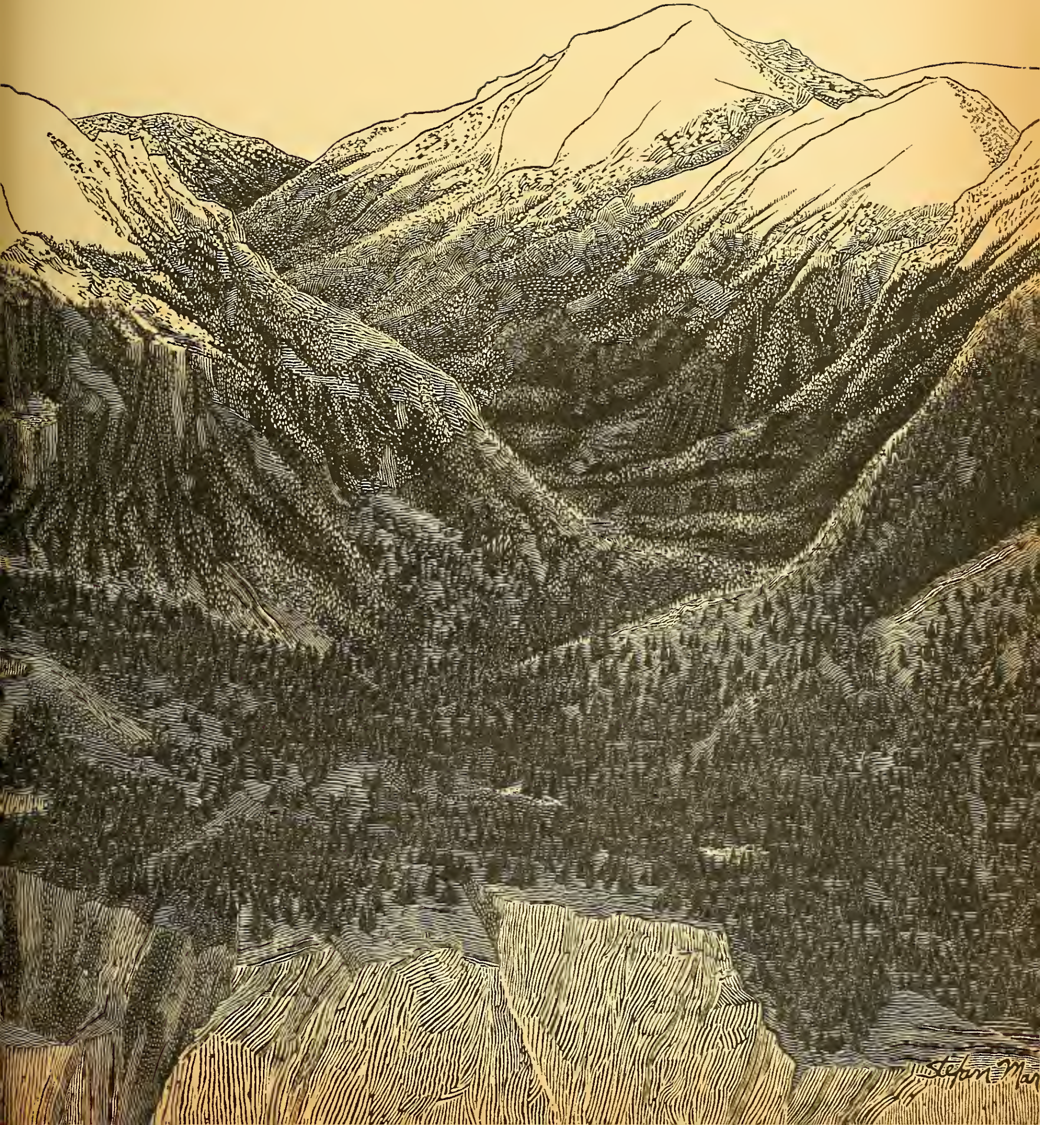
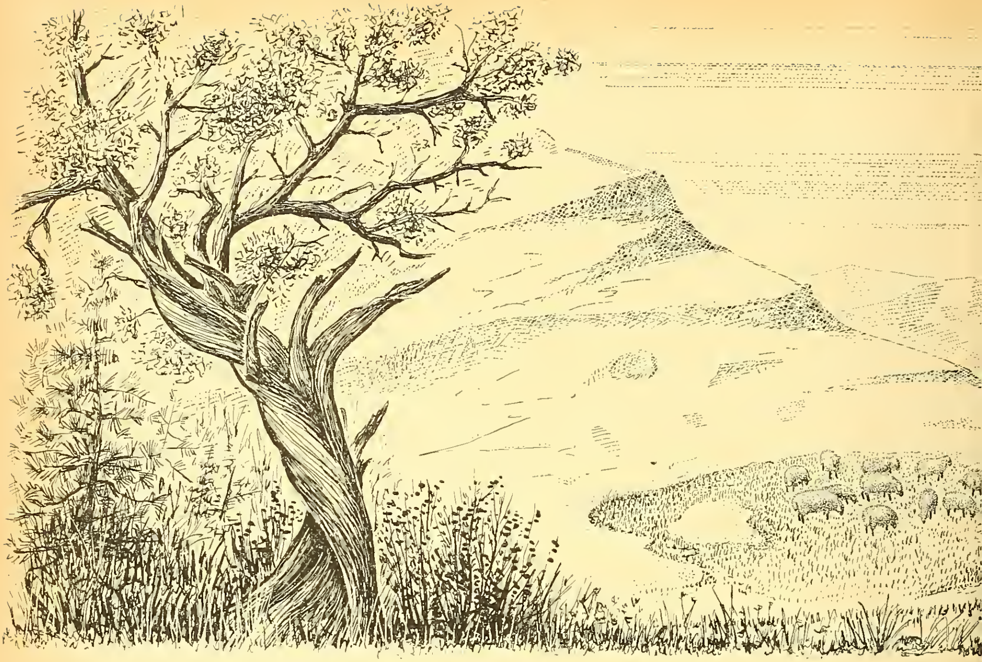




LIFE AT TIMBER LINE

Industry and vigilance the keys to survival in a harsh environme

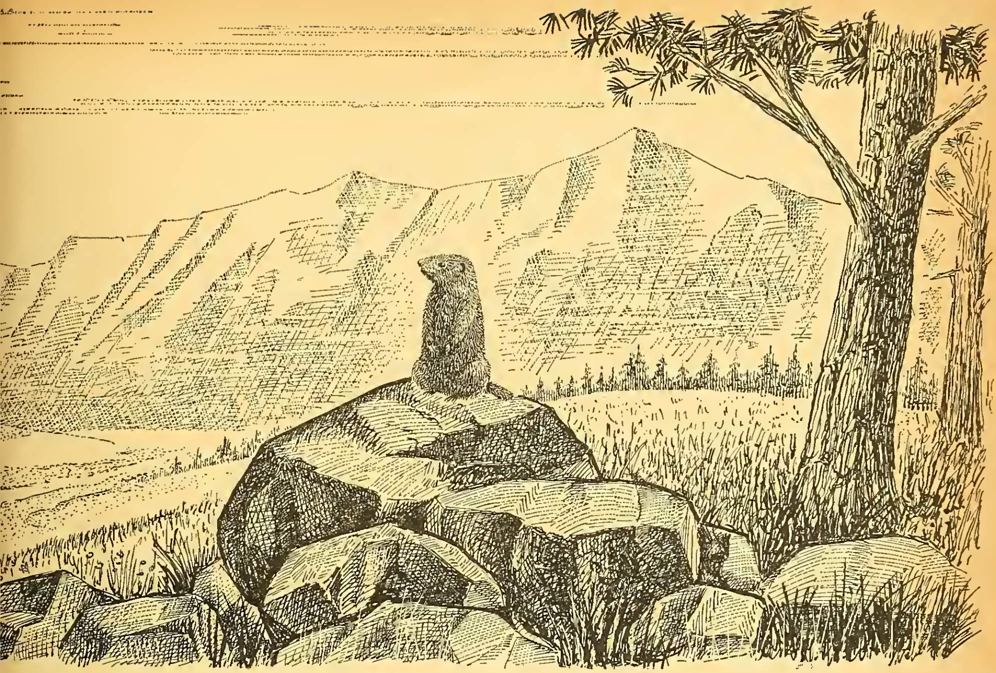
By E. Laurence Palmer

Anyone who has seen some of our higher American mountains—or even photographs of them—has probably noticed two more or less horizontal lines upon the mountainsides, one above the other. These are the snow line and the timber line. The snow line moves up and down the mountainside with the change of the seasons, and, with the shifting of this line, many animals must move or be destroyed. The timber line may disappear temporarily when its plant life is buried in snow, but it displays a surprising persistence of level.

Trains, buses, and automobiles speed across the continent, for the most part following, through mountainous areas, valleys that are below the timber line. Relatively few summer tourists find it possible to reach that mysterious line, and actually see for themselves the conditions of life that obtain there. It is well worth the effort to climb up through the densely wooded lower reaches of a high mountain, to emerge finally in an area where the horizons are distant and thrilling, and where movement is not impeded by crowded plant life.

Personally, I know of few outdoor experiences more exhilarating than a long hike up some steep moun trail with camera or other equipment, through wooded country and into the open territory of timber and an entirely different world. Both the mount themselves and their animal populations are well w a better acquaintance.

Seldom does the timber line run at a uniform he completely around any given mountain. The prevai winds on one side of the mountain may force warm from the lower levels upward, raising the timber line that side, while the cool winds coming down the oppo side may contribute to lowering the line there. After have climbed a mountain to its timber line it migh interesting to note, while you still perspire, in which p tion your face cools the most quickly—in an uphill downhill, attitude. If opportunity offers, you might this same experiment at different times of day to se there is any change in the direction of fastest cool Ordinarily, however, when you are above timber l you will not need to make any fine measurements to you from which direction the wind is blowing.



From a rocky perch the hoary marmot whistles at intruders.

s you start to explore timber-line territory, you will probably notice, on cloudless days at least, that the nlight is more intense than it was in the lower, timbered nes, and that the winds are likely to be stronger. These o factors are possibly the most important of those that vern the animal life to be found at timber line. The n, of course, directly influences the temperature. When e winds are high, they may actually affect the climbers' ility to move about—or even, for that matter, his ility to remain motionless.

It may pay you to pause above timber line and sit wn for a while—an action that, at this particular time, ay come as a most pleasurable experience. If you do, nay be profitable to perform a few simple experiments d to make a few observations.

It may be found that the territory above timber line well covered with low vegetation, or perhaps with arse, compact vegetation. It may also be characterized bare soil or bare rock. Rarely will the soil be deep, cause loose soil will either have been washed or blown ay. If the permanent snow line is not far above the nber line, it may be found, by probing with the fingers, it the region of frozen soil is relatively close to the rface. This means that animals—like some of the in- cts, earthworms, and spiders—must live in a relatively nin" world compared to the world of those below. It also means that plants found at timber line must able to survive freezing, a circumstance that elim- ates most of our annuals from a list of timber-line flora. ith these plants missing, the animals dependent on em are, of course, also missing. This does not mean that there will be no plants above timber line, because actually there may be many. Those that do thrive may provide excellent forage for animals. Many domesticated sheep may also crowd up the mountainsides into high pasturage, and usually such areas suffer as a consequence, unless grazing activities are closely and intelligently supervised by the responsible interests.

The upland pasturing of sheep may be a convenience to the sheep industry, but it is rarely beneficial to the plants of timber line. Sheep trails well may characterize much of the territory above timber line in many parts of the world—in our own West, in Europe, in New Zealand, and elsewhere. Domestic sheep, mountain sheep, and mountain goats are more likely to be found above timber line than are animals not protected by heavy coats of wool. In summer, antelope, deer, and elk may move up into these higher altitudes, but when weather conditions become severe they move back to warmer, lower levels.

WHEN such mammals move up and down mountains, they may, of course, carry with them their parasites. Some of these parasites may be of such nature as to be dangerous to humans. Ticks, for example, may carry the Rocky Mountain tick fever organism, which can be fatal to human beings. When most ticks reach maturity, they drop to the ground, lay their eggs, and thus provide the next generation. The young ticks hatch, climb a nearby plant, and attach themselves to such cattle, human beings, or game mammals as may rub against the plants. In gorging themselves with the blood of their hosts, the ticks may free into mammal blood-streams the organisms that cause Rocky Mountain fever. For this reason, at least, it may be well, when roaming grassy areas at or near timber line, to be so dressed that the ticks cannot reach your body, and to make a practice of going over the body thoroughly each night to remove any ticks that may have chosen you as a host.

Much of the territory at, or above, timber line is merely bare rock. This may be broken or unbroken; and if it is broken, there may be an abundance of rock piles in which there will be many crevices below the surface. This world of loose rock is commonly the domain of a considerable number of animals. Probably most conspicuous among these are the marmots, which pose on some high point of rock and whistle excitedly at the intruder as he explores their territory. If the visitor gets too close, the animals quickly scurry to safety, but if he follows up such a brief acquaintance with them, he will find that in all probability these mammals leave trails through the vegetation similar to those made by woodchucks at lower levels. Marmots may hibernate for as long as eight months a year, so the remaining four months must be a time in which to eat, grow fat, and raise a family, as well as to avoid enemies and generally make the most of the short season. Is it any wonder that the marmots resent intrusions on their activities?

The rubble heaps of the mountainsides near a timber line may well be inhabited by animals even smaller than the marmots. Among these may be the conies, or, as they are sometimes called, rock rabbits or pikas. These little, eight-inch, round-eared, practically tailless mammals may be active throughout the year, in spite of the fact that they must feed on plant life, even under the deep snows of the long mountain winters. To guarantee survival under such conditions, pikas spend much of their summertime collecting, drying and storing plant food in crevices under rock piles. So diligently do they work that their hay piles may become rather substantial, and in time of crisis they may also be welcomed by an exploring sheep. In this way the pika may actually save the sheep's life; while the sheep, in return, destroys the plants on which the pika must live.

The pika is not alone in making its home in crevices under rocks, storing its food treasure, and finding safety there. Pack rats, which may obtain a length of eighteen inches, may live somewhat similar lives. They may be most active at night, and sometimes do not limit their collecting to plant food. In fact, they may appropriate any loose item that appeals to their fancy. If you camp in pack rat territory and leave a spoon lying around, it may vanish during the night. The items that a pack rat will pick up around a campsite, while their owners sleep, can be surprising. It is also surprising how much jewelry left on a "motel" bedroom table can vanish when a pack rat makes its entry through some convenient open window. If an article is lost around camp in pack rat territory, it is safer to put the blame on the pack rat than on your campmate. The pack rat will, however, probably have hidden the missing items safely away under some pile of rocks where they likely will never be seen again.

Meadow mice and shrews, and their enemies the weasels, may live their usual lives in timber-line territory. Coyotes, hawks, and now and then a large owl may visit timber line, to make a few meals from the l
animals that live there, and which are sometimes pre
in surprising abundance.

It is only the work of a few minutes to explore a pa
of timber-line vegetation, or to turn over a few ro
here and there. It will then become obvious where l
animals have been at work, eating, fighting, rai
families, or just exploring.

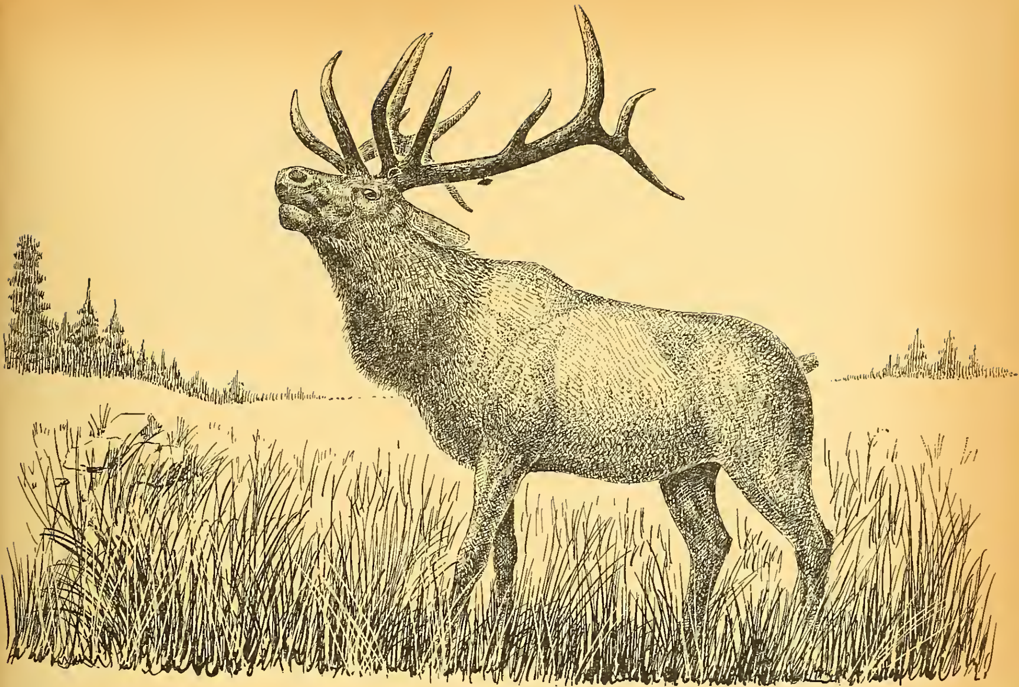
Of course, these smaller animals are not as spectac
as the larger sheep, goats, elk, deer, or antelopes that
be found at timber line, but they are more likely to
present when you arrive for a visit, even though they
not as easily seen. There is no doubt that the small m
mals affect their surroundings to a considerable ext
If the visitor fails to see mountain goats and sheep
should not regard his visit as a complete failure.
should explore territory that has been used by pack
pikas, marmots, mice, and shrews; and he should
overlook either the invertebrates or the birds of tim
line. They are well worth investigation.

If the visitor is interested in birds, he may find pl
of sights to hold his interest at timber line or ab
timber line. Some of the birds found in these regi
never descend to the lowlands, but many are of the s
species as may be found in the lowlands during wi
and spring. It is hardly to the credit of humans that
have allowed such interesting timber-line birds as
ptarmigan to be killed in large numbers.

Of the three groups of American ptarmigan, we
elected to supply the reader with some information
the white-tailed ptarmigan that ranges intermitte
along the Rocky Mountain highlands, from south
Alaska to New Mexico. You may easily travel thro
ptarmigan territory and never see one of these birds.
white-tailed ptarmigan, in its winter plumage, may
almost wholly white except for its bill. Such a bird, sit
quietly on a snowbank, is not conspicuous, particul
as it may not make a move until the last safe mom
In summer, the bird may be a flecked brown and w
while the tail, the breast, and much of the wings rem
pure white. It is a bird that may be easily passed by
remains motionless—which it usually does.

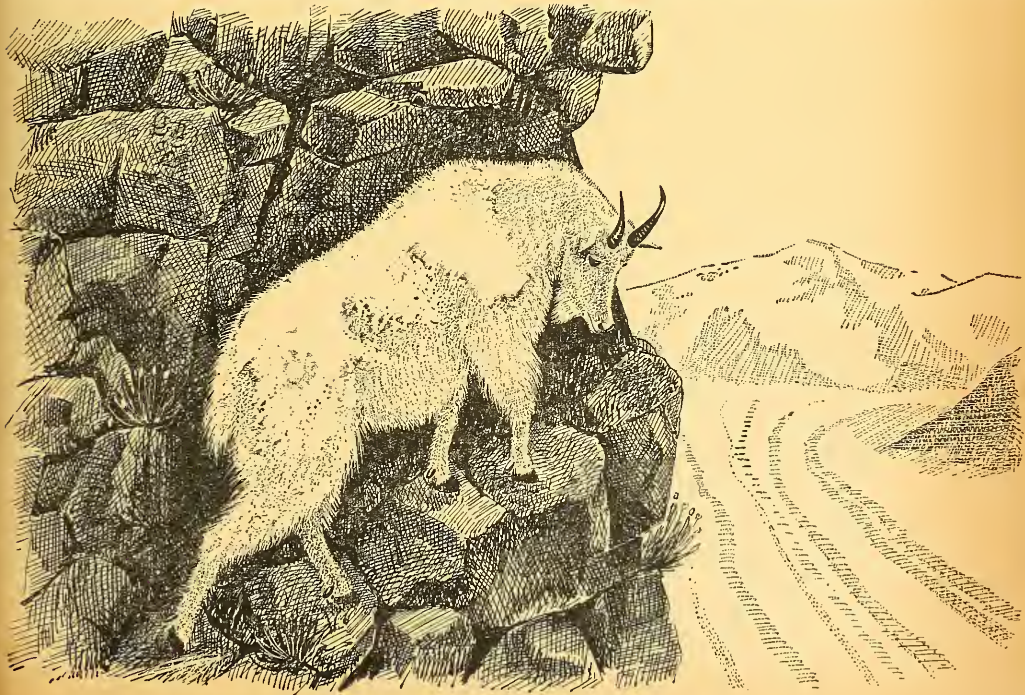
Timber-line territory in the mountains, and part
larly that of the mountain passes, is a favorite loc
of the bird watchers, especially during migratory seas
Great numbers of various birds move north or south
the seasons, and some of these must cross moun
ranges. The easiest place to cross such barriers is w
the ridges are the lowest, or in the passes. Bird watc
find it worth their while to visit such areas, and iden
and count such birds as may make use of a pass du
a single day of the migratory period.

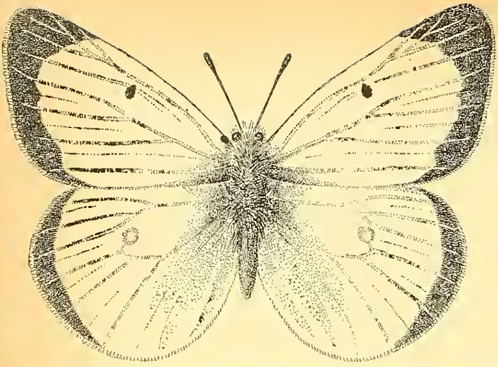
The Hawk Mountain sanctuary in Pennsylvania,
example, is a place where hawk migrations may be p
itably observed. Fortunately, the great value of hawk
man's scheme of life is beginning to be more univers
recognized, and the wholesale slaughter of these b
during their migrations has been somewhat lessene
may be regrettable that this change in human attitude
had to be accomplished by the passage of laws, but so
times such drastic action seems to be the only way
protect animal life that is essentially beneficial to m



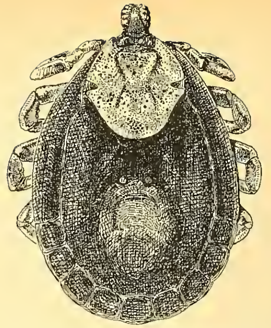
Wapiti, or elk, is a summer dweller in the high meadows; male elk, shown above, may attain a weight of 750 pounds.

The chilly slopes and peaks of the American Rockies are the habitat of sharp-horned, chunky mountain goat, *below*.





Butterfly of alpine zone is giant sulphur, *Colias gigantea.*



Rocky Mountain spotted-fever tick, *Dermacentor andersc*

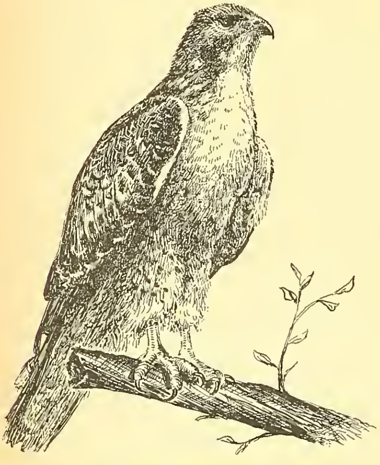
In the West, the timber-line area of the mountains may be visited by red-tailed hawks. These are the most common of the larger birds, but golden eagles and bald eagles may come now and then to explore the territory. For such birds, however, life there is not prosperous.

There are a number of smaller birds that may be found at timber line, some of which are most interesting. The horned larks that we sometimes see in large flocks during winter may spend much time at, or near, timber line in the open country. In such flocks, there may be a pipit—a bird that is usually not particularly common over its range—but whose range covers much of the world, including North and South America, Europe, Asia, and Africa. This is indeed a cosmopolitan bird.

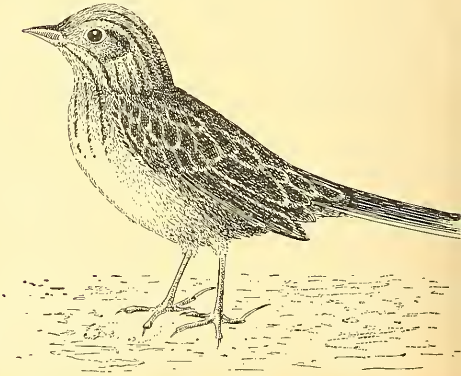
The pipits and horned larks walk or run over the ground, using their legs alternately. The sparrows—and the rosy finches with which they are sometimes associated—hop, rather than walk, and the tracks made by such hopping or running over the snow may help to make a determination of a bird seen near snow line. Even though the season may be short, a considerable number of birds are able to build nests and rear families at and abo timber line. Of course, they are not likely to rear seve broods a year, but that apparently is not necessary, si these populations do not seem to be dwindling to a alarming extent as far as can be ascertained.

In some respects, birds living at timber line, close the snow line, find themselves in an ideal situati Warm breezes from the lowlands may constantly pu uphill with the prevailing winds. These breezes sor times carry with them hosts of flying insects that forced high enough to bring them to the region of nun ing temperatures. The insects cannot continue th flights, and many of them come to rest on a snowba where their dark color makes them conspicuous, a easy prey for hungry birds.

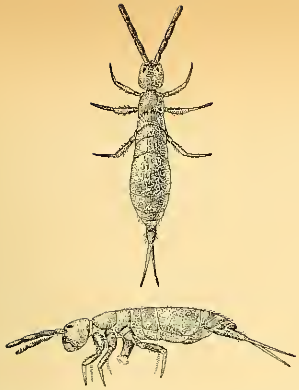
This logically brings us to the insects that may found at and above timber line. One surprising encou ter, in the course of a hike over the snowfields at timl line, may be with a few butterflies, and other insec The last time I was above timber line in New York Sta my attention was attracted by some flies and bees. T



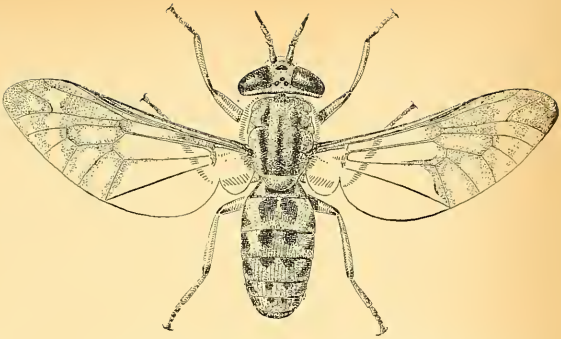
The red-tailed hawk, *Buteo jamaicensis,* may now and then invade timber-line territory in search of small mammals.



Nest of the American pipit, *Anthus spinoletta rubesce* may be found above tree line on cliffs or among grass



nber-line snow fields may swarm with tiny, dark "fleas."



The swift deerfly may now and then visit the timber line.

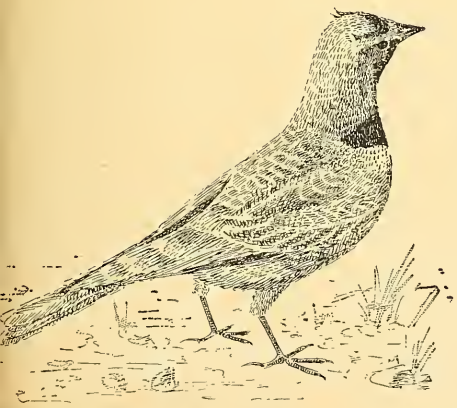
es were bumblebees, and the flies looked much like bees, superficially. They proved to be large deerflies insects whose life histories are most unusual.

HE Collembola, primitive insects that are found in great numbers on the snow at high altitudes, also ve remarkable life histories and living habits. They y move about actively on snowbanks during the day-ıe, feeding on pollen that has been brought up to the ghts from trees farther down the mountain. With the of night, the insects may become frozen into the snow-ıks, and thus are forced to suspend operations for the ht. With the coming of the sun in the morning, their k bodies absorb heat rays, and they are soon free to hopping about on the snow like tiny black dots.

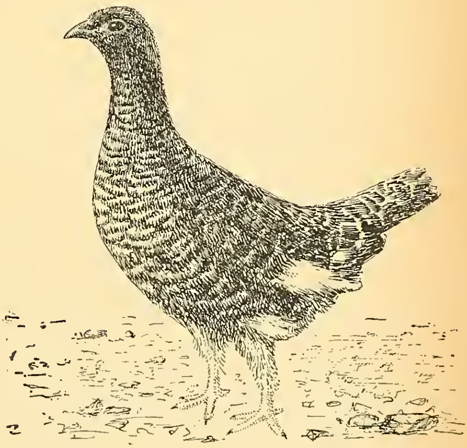
Alpine butterflies may require temperatures of from °F. to 59°F. to be active. This is a temperature range t may obtain during several of the summer months, d allows time enough for such butterflies to mate and eggs. The caterpillars may feed on the dwarf willows d other plants of timber line, and the pupae may develop in places where there is some reserve heat. We know that the common cluster-flies that haunt our homes in spring and autumn become active when the temperature reaches 50°F., and it does not require much more warmth to enliven the butterflies.

IN general, the caterpillars of both the alpine and arctic butterflies are well covered with hairs, a characteristic of most animals that live in cold climates. The fact that many of the rocks of timber-line territory are dark contributes to the heat-absorbent properties of the region, and so it is not surprising that the pupae of such snowbank butterflies may frequently be found hidden under exposed rocks.

Perhaps in a coming insert we may take another trip on paper to the timber line, there to become better acquainted with the plant life to be found. The plants of the timber line may not be as eye-catching as the leaping mountain goat, the soaring eagle, or the jumping snow flea, but they have their own characteristics, some of which are of challenging interest.



mophila alpestris, the horned lark, is a far-ranging cies with representatives from seacoast to alpine zone.



At home above tree line of the Rockies is white-tailed ptarmigan, *Lagopus leucurus,* shown in its summer plumage.

For symbols explanation, see School Page.	DESCRIPTION	RANGE AND RELATIONSHIP
Rock Chuck, or Hoary Marmot *Marmota caligata*	May exceed 30″ in length, including tail. Usually silver-gray, peppered with black. Black areas on face, white areas on forehead or face. Feet are black. Teeth I–1/1, C–0/0, P–2/1, M–3/3. Tracks, F–1″ x 2″, 4; H–1½″ x 1½″, 5. Sp. 4″. Family Sciuridae.	Nine subspecies recognized in the sp cies in North America, and five speci in the genus. Range, from Arctic Circ in Alaska into Washington, Idaho, ar Montana; also into California and Ne Mexico. Marmot is to the mountaino highlands what the woodchuck is areas of lesser altitude.
Pika, Cony, or Rock Rabbit *Ochotona princeps*	Length to 8½″. No external tail of consequence. Shoulder height to 3 ½″. Weight to 6 ozs. Summer fur about 2 months. Ears relatively short. As in rabbits and hares, there are 4 incisors on upper jaw. Teeth, I–2/1, C–0/0, P–2/2, M–3/3. Usually hop or leap rather than run or walk. Ochotonidae.	In North America, one genus, tv species, and 31 subspecies. Second pa of upper incisors hidden behind tl larger pair. From near sea level north to over 13,000-foot level in Ne Mexico. In southeast Alaska, in mou tainous western Canada and U.S.; b not in western Alaska.
Bushy-Tailed Pack Rat *Neotoma cinerea*	Length to 17½″, but appears to be larger than the related *N. fuscipes,* which is ½″ longer. *N. fuscipes* is the dusky-footed pack rat. Teeth, I–1/1, C–0/0, P–0/0, M–3/3. Track F–1/2″ x 3/4″, 4, H–3/4″ x 1″, 5. Hair on tail of bushy-tailed pack rat may measure 4/5″ long. Cricetidae.	*Neotoma* is represented by nearly species in North America, and t species *N. cinerea* has over a doz subspecies. Bushy-tailed pack rats a found north of central Cal., and fro northwest Texas to the Dakotas ar through British Columbia. Closely r lated forms extend the range.
Coyote *Canis latrans*	"All coyotes like to hunt at night. They bark and howl and snarl and fight and two can fuss around a feast and sound like five or six at least." Length to 4′. Weight to 30 pounds. Ears long. Tail carried low. Teeth, 1–3/3, C–1/1, P–4/4, M–2/3. Tracks, F–3″ x 3½″, 4; H–3″ x 3½″, 4. Canidae.	Ranges from Alaska to Central Ame ica, east to Florida and New Yor Crosses between coyotes and dogs b coming commoner. Individual ran about 6 square miles, but if disturb may increase this considerably. No mally favors relatively open count but may be found in brushland.
Mountain Goat *Oreamnos americanus*	"The mountain goat's a funny sight. His shaggy hair is long and white. His little horns are sharp and black. He has a hump upon his back." Length to 5½ feet, including 6½-inch tail. Track, F 2¾″ x 2¾″, 2. H, 2½″ x 2½″, 2. Teeth, I–0/4, C–0/0, P–3/3, M–3/3. Family Bovidae.	Rocky Mountains in U.S., and nor into Alaska. Spends summer in hi mountain pastures and may winter lower levels, usually in family grou Four subspecies now recognized, sou to Idaho and Montana, surviving parks and sanctuaries. Range of i dividuals usually limited.
Mountain Sheep *Ovis canadensis*	"This fat old ram is big and burly. His heavy horns are long and curly." Length to 7 feet, including 5½″ tail. Shoulder height to 3½″. Rams' horns to 4′ long, round the curve. Ewes' horns shorter. Tracks, F, 2¾″ x 2¾″, 2. H, the same. Teeth, 1–0/4, C–0/0, P–3/3, M–3/3. Family Bovidae.	Two species, including 9 subspec recognized in North America, wi dark brown to black Dall's sheep us ally north of Canadian border, a bighorn south of border into Mexi Both confined to the mountaino West. Must have access to water, a require salt periodically.
Pronghorn Antelope *Antilocapra americana*	"This graceful pronghorn antelope goes racing down the grassy slope. His legs are slim and full of power. He travels 40 miles an hour. He isn't like a deer, you know. The buck has horns; so has the doe." Bucks to 140 lbs.; does to 105 lbs. Teeth, 1–0/4, C–0/0, P–3/3, M–3/3. Antilocapridae.	From southern Canada to northe Mexico, along highlands from Mo tana, south. At their best on op prairies and high tablelands, but m appear above timber line. Shuns t sage and overeroded lands. Individu range over 3 square miles, and c easily travel 20 miles a day.
Wapiti, or Elk *Cervus canadensis*	"With stately antlers branching wide, the bull elk roams the mountain side and sends his mating bugle calls resounding down the canyon walls." Bucks or bulls weigh to 750 pounds; to 9 feet long. Dark chestnut mane and gray rump. Cows to 500 pounds, without antlers. Family Cervidae.	"In days gone by the elk was fou from Chesapeake to Puget Sound a ranged the forests all the way from R Grande to Hudson Bay." Present ran of the wapiti is limited roughly by ar between British Columbia, Montar Arizona, and New Mexico. Tee I–0/4, C–1/0, P–3/3, M–3/3.
Mule Deer *Odocoileus hemionus*	Mule deer and black-tailed deer are two varieties of the same species. Buck mule deer weighs up to 200 pounds, as against 275 pounds each for black-tailed and white-tailed deer. Tail of mule deer is slender at base, and black-tipped. Teeth of all are I–0/4, C–0/0, P–3/3. Cervidae.	Mule deer ranges from northern Me ico to northern Manitoba and we except in parts of western Washingt Oregon, and California. Black-tail deer favors woods from western slo of Sierras and Cascades to the sea, a north into southern British Colum and southern Alaska.

REPRODUCTION	ECOLOGY	ECONOMY
Mate in spring, and 35-42 days later 2-5 young may be born, usually about June 1. Young may run with mother during the first summer, may occupy common den first winter; but when next litter is born family breaks up. Young sexually mature at age of 2 years. Life span is to 13½ years.	Hibernation may last 7 to 8 months. Pulse is 120 to 206, depending on activity, and body temperature may vary from 93-103° F. Food almost wholly plant material, often reached by well-marked trails from den, which may be well hidden in a rock pile inaccessible to lurking enemies.	Serve as competitors for forage with sheep, goats, deer, and other plant-eaters of the range. Wearing value of pelt is low, being only twenty per cent that of otter. Russian marmot is sold commercially as "Brazilian mink," although it does not come from Brazil, and is not mink.
First litter born by May and latest by September, there being 2-5 young, each weighing 1/3 ounce. Young are darker than adults, and are weaned when about 1/3 adult size. Young born 30½ days after breeding, and usually two litters a year. Born in nest hidden under rock or rock pile.	Feed on plant material, which is dried and stored for winter use. When excited may give loud whistle, thus name "whistling hares" that is sometimes applied to them. Body temperature 102° F., durability of fur twenty per cent of otter. Pair may store over a peck of food in one place.	Compete slightly for food with grazing animals, but provide much of basic food for fur bearers of region. Stored food may serve in emergency for sheep in times of distress, and lost campers have found such stored food excellent for starting needed fires during periods of severe weather.
Pack rats breed throughout the year, with young born 5-6 weeks after the mating. Males beat ground with feet during courtship. Probably are monogamous. One to four young to a litter, weight 1/3 ounce at birth. Young are furred in two weeks and may leave parents in three weeks.	Females may reach maturity at 200 days of age. Pack rats eat perishable foods, and store those that keep well in rock piles, hollow trees, buildings and stumps. May steal baubles prized by men and store them, often causing great confusion and unjustified recrimination among human victims.	May serve as food for fur-bearing and feather-bearing predators of the region, and may compete with local grazing animals for forage. Stored food may provide needed ration for starving animal during critical times of the year. Nocturnal activities are most interesting and sometimes aggravating.
Probably pairs for life, breeding early in year and bearing 5-10 blind but furred pups in 60-65 days. Pups may venture out on own at 6 weeks, but usually stay with parents until fall. Young are fed at first by female, who is fed by male; but later both parents provide food for family.	Eight thousand stomachs examined showed 33% with rabbit, 25% carrion, 18% with rodents, and 13% with sheep and goat. Full meal equals 1¾ pounds, or 2 ground squirrels. Winter diet indicated by 2,500 stomachs was 36% carrion, 34% rabbit, 15% rodent, 8% sheep, and 3% deer.	Sheep and cattle are dependent on forage that is destroyed by rabbits and rodents, whose greatest natural enemy may be the coyote. Control may be necessary at times, but normally coyotes perform a most useful role. May kill much small game. May spread rabies in domestic dogs.
Probably monogamous, with buck and doe living together through summer. One young born 6 months after mating, with kid standing 10 minutes after birth and nursing in 10 minutes. At 2 days of age may stand 13½ inches high, and weigh up to 7 pounds. Mother defends her young vigorously.	Feeds only on vegetation, and is able to get food from under snow when necessary. Enemies of mountain goats include the elements and the hazards of mountainous terrain, but they may also be killed by wolves, cougars, and, of course, by man. Unguarded kids may be killed by eagles.	Submit to semidomestication in parks and zoos, and so may survive indefinitely, but in the wild these handsome mammals need protection. Animals in natural environment lack the subdued character of confined counterparts. Might share diseases of domestic animals.
In November, rams fight for ewes. Rams to 320 pounds; ewes to 175 pounds. 1-2 lambs born 180 days after mating. Lambs can run at 2 hours' age. Rams reach prime at 8 years, and life span is to 15 years. Ewes breed at 2½ years; rams at 3½ years. Lambs often with mother to 2 years.	"He must watch where'er he goes because his kind has many foes. For pumas catch the ewes and rams and eagles steal the baby lambs, and hunters seek him in the fall to hang his head upon the wall." Has remarkable sight, but poor sense of smell. Exceptional speed over rough terrain.	Provide food and "sport" for men, and hides have some value. May compete with domestic animals for forage, but are so exceptional that they deserve protection to guarantee survival. There may be some association with diseases of sheep and those of animals with which they are found.
Both sexes horned, with sheaths over bony cores, sheaths shed annually. Buck black on face and side of neck, with horns longer than ears; by fighting, collects harem of up to 15 does. Bucks breed at 2 years; does at 15 months. In 230-40 days, 1-2 kids are born, each weighing 4-5 pounds.	Food is solely vegetation. Herds kept together by bucks, or by flashing white rumps. Mother alone defends young. May migrate in winter from highlands to suitable food areas at lower levels, usually as a herd. Preyed upon by coyotes, wolves, and men. Men will determine survival.	Beautiful competitors with domestic grazing animals, but worthy of protection from extermination. Exceptional curiosity is a factor in their destruction by hunters. Flesh is excellent food. Original population may have been 40 million, now reduced to neighborhood of 100 thousand.
Bulls' antlers may begin to shed "velvet" in August, but rut is at height in September and October, when bulls may establish harems of 15-30 cows. From 210-62 days after breeding, 1-3 calves weighing to 30 pounds are born. May follow cow in 3 days, and start to graze in 4 weeks.	Bulls may mate with domestic cows at almost any time of year. Antlers shed about March, with new set starting immediately. Each succeeding year usually larger over 10 year period, with maximum to about 5 feet. May leap to height of 10 feet. Tracks, F 3½" x 4½", 2. H 3¼" x 4", 2.	May serve as competitor in grazing with domestic cattle, and bulls by serving domestic cattle may reduce normal number of calves. However, they are such popular "game" animals that they provide a profitable attraction for hunters, and bolster the economy of some low-income areas.
In mating season bucks do not maintain closely knit harems as do elk and antelope, but attempt to dominate a herd or drive ruling bucks away. Mating season may last two months, with 1-3 fawns born seven months after mating. May stay with doe 2 years. Life span to 7 years.	Herding in winter may create food crisis, with difficulty for the young animals that cannot reach browse. Starvation is common. Enemies include coyotes, bears, cougars, men, and feral dogs. Many of these deer are held captive, and may be seen in public parks and sanctuaries.	Useful game animals that in summer occasionally range upward above the timber line; but are essentially at home at lower levels. The expansion of the range in summer by the retreat of the snow line reduces competition during time when the new generation of mule deer is being established.

For symbols explanation, see School Page.	DESCRIPTION	RANGE AND RELATIONSHIP
TICKS *Family Ixodidae, Genus Dermacentor*	Birds and mammals ranging through treeless areas above timber line may be attacked by ticks. Female Rocky Mountain spotted-fever tick, *D. andersoni*, has body to 2/5" long, reddish-brown. Male has body under 1/5" long. Larvae live on small animals. Adults favor man, larger animals.	*D. andersoni* is found mostly in th northwestern part of the United States commonly in mountainous areas. Ther are some sixty kinds of ticks in Amer ica, most of which are annoying, an some of which may carry organism that produce diseases fatal to man an his domestic animals.
ALPINE INSECTS	Timber-line territory boasts many animals other than mountain goats and sheep. Insects and other invertebrates are present, most of them belonging to groups like the Coleoptera, Diptera, Lepidoptera, and Hymenoptera. Groups like the Orthoptera and Hemiptera are sparingly represented.	Where world climatic conditions ar similar, there are remarkable similari ties in the animals to be found. Col nights rule out an abundance of com mon night-flying insects. Soil froze for long seasons interferes with the de velopment of insects that spend muc time underground.
SNOW FLEAS Collembola	Snow above timber line may at times be covered with dark, wingless insects under 1/5-inch long, some of which may leap without direction, while others crawl. Springtails are usually shorter than snow fleas, and leap by freeing bent tail tips from under body, hurling insect into air.	The Order Collembola includes spring tails of the Family Sminthuridae, an snow Fleas of the Family Poduridae with the former usually found in th drier areas. *Achorutes nivicolus* i most conspicuous as a jumping gra dot on the snow. Some members o the family lack ability to leap.
GIANT SULPHUR BUTTERFLY *Colias gigantea*	Sulphur butterflies are best known as yellow and black butterflies seen about fields in considerable numbers. It is sometimes surprising to see an abundance of butterflies near snow. Giant sulphur measures to nearly 2"; females may partly lose the characteristic dark wing borders.	These butterflies are found in th Rocky Mountain highlands as far sout as the mountains of New Mexico. number of species of *Colias* are alpin or arctic, and the related genera c *Erebia*, *Oeneis*, and *Boloria* may hav many representatives to be found at o above the timber line.
RED-TAILED HAWK *Buteo jamaicensis*	Wingspread to 44". Length to 23". Tail 9.7". Female commonly the larger. Weight to 3 pounds. Characterized by large size, white underwings (darker in western variety), black-tipped flight feathers, dark band across lower abdomen. Tail brick red. Commonly flies in high spirals. Call, a shrill "kree-e-e."	Six subspecies include Eastern, Flo ida, Krider's, Western, Alaska, an Fuertes'. In Western, throat is distinc ly streaked. Red-tails breed throug southeastern Canada to northeaster Mexico and north to tree-limit in Car ada. Winters Kansas to N. Y., sout through eastern Mexico.
WHITE-TAILED PTARMIGAN *Lagopus leucurus*	Length to 13", being our smallest ptarmigan. In winter, adults are pure white with only bill appearing black. In summer, back, neck, head, and breast are marked with brown, gray, and white, while the tail, most of the wings and lower breast are pure white or dark-flecked.	Ranges from central Alaska and nort ern Yukon intermittently south alon the Rocky Mountains, from Britis Columbia and Alberta south into nort ern New Mexico. Six subspecies recog nized, with three species in the genu including white-tailed, rock, and wi low ptarmigans.
HORNED LARK *Eremophila alpestris*	Length to 8 inches. Tail to 3.1 inches. Wingspread to 14 inches. Female smaller than male. Male brown above and on sides, with face and throat yellow, black across forehead, on side of head, and across throat. Shows black tail with white corners and contrasting white belly in flight.	One species and 21 subspecies in Nort America. Species ranges through mo of North America, most of Europ much of Asia. In North America, sout to Baja California, southern Mexic and Texas to North Carolina. Repre sentatives of the genus are found fro sea level to alpine zone.
AMERICAN WATER PIPIT *Anthus spinoletta rubescens*	Length to 7 inches. Tail to 2.85 inches. Wing to 3.5 inches. Upper parts grayish-brown, with 2 buff bars with light edging on wings. Tail blackish-brown, with outer feathers mostly white and second feather white-tipped. Underparts are light buff, chin light. Chest is dark-streaked.	Breeds northern Yukon to Greenlan Scandinavia, Europe, the Caucasus an southeastern Siberia. In winter goe south to northwestern Africa an Egypt, and in North America south t Florida, and Baja California to Guate mala. From sea coasts to above timbe line. Five closely related species.
GRAY-CROWNED ROSY FINCH *Leucosticte tephrocotis*	Adult male in summer with black bill and black crown, bordered behind and on sides by gray. Body deep chestnut brown. Pink tinge on belly, rump, tail coverts, and wings; in winter, with yellow bill tipped with black, and brown feathers edged with white. Female paler, duller than male.	A sparrow that ranges through wester North America, breeding in mountain above timber line in British Columbi and the Yukon, south into Washingto and Oregon, east to Idaho, Colorad and Utah. The gray-crowned winter in British Columbia, black-crowned i Idaho, Colorado, Utah.

REPRODUCTION	ECOLOGY	ECONOMY
After fertilization, eggs are laid on the ground, and the young climb vegetation and rub off on the body of a passing animal. They feed on the blood of their hosts, and may become infected and capable of infecting other hosts for several months, either as larvae or mature of either sex.	Reservoirs of infected blood may be found in many animals. The adult ticks can pass disease through eggs to another generation, but the disease cannot be transmitted from a diseased animal directly to a healthy one. Therefore, control is largely a matter of tick control, chemically, or by other means.	Persons hiking tick country or lying on ground in such areas should search bodies carefully, periodically, to locate and remove any ticks that might have become attached. Domestic animals and poultry may be hosts to ticks, which should be removed and destroyed when found.
In general, insects with egg, larval, pupal, and adult stages survive alpine conditions better than those with incomplete metamorphosis. Exceptions may be the Collembola, considered immediately below. Where season for activity is short, surviving invertebrates must develop rapidly.	Strong winds of alpine areas limit activities of many free-flying insects, but some butterflies, bumblebees, beetles, and flies can exist under such conditions. Dark rocks exposed to sun absorb heat readily and help insects and other invertebrates of area to develop.	The role of invertebrate life of timber line is primarily that of feeding birds and insect parasites. Mites, ticks, and similar invertebrates are somewhat successful. A great proportion of timber-line invertebrates are brought up the mountainside from lower levels by winds—to die in the chill environment.
Young are much like adults, but the details of reproduction are not well known. Insects seem seasonally abundant, so there may be some relationship between climatic conditions and reproduction. While numbers are sometimes enormous, at other times insects are not to be found.	Snow fleas may feed on pollen on the snow, and probably on other organic material. They may freeze in snow and be inactive through night, only to resume active feeding and movement when warmed by sun. Apparently have no true breathing organs, and must respire through body surfaces.	Snow fleas such as are seen on snow above timber line probably have no great economic importance. Their relatives living at lower levels may appear in enormous numbers during maple sugar time. Some Collembola are controlled by a Bordeaux spray mixed with pyrethrum powder.
Because of the short season, there may well be only a single local generation a year. Males and females vary over the range, with northern specimens averaging more white females than yellow. Caterpillars of timber-line butterflies are commonly covered with fine, woolly hairs.	Food of *Colias* caterpillars is largely the willow, and the insects provide forage for the horned larks and pipits that are sometimes to be found in the area in great flocks. In the Himalaya Mountains, some butterflies have been found at altitudes approaching 20,000 feet.	The economic role of alpine and arctic butterflies is obviously small, since there are few plants and animals to be found in such localities that are of great economic importance. Butterfly larvae feed on timber-line plants, and in turn provide food for the birdlife of the timber-line area.
Nest is huge pile of coarse sticks, commonly placed high in a tree to 40 feet above ground, or on a cliff. Eggs 2-4, dull white, irregularly marked with cinnamon brown, measuring 2.5 by 2 inches. Incubation is 28 days by the female. One annual brood. Young blind, slightly downy.	Food mainly mice, small rodents. Poultry and game constitutes less than 10% of total, and may be limited to a few individuals. Normally food is of animals that are primarily destroyers of forage useful to domestic animals reared by man. A most valuable check on mouse infestation.	Except around game farms, is probably one of most useful of all hawks, and is protected by law in most states where its worth is recognized. It is usually a shy hawk. Its usually unbanded tail, white area on breast, and streaked breast may be sufficient for accurate recognition in the field.
Nests on ground in a depression, in either a bare or mostly exposed position, with some grass as lining, and often a few feathers. Eggs, 8-15, dull cream-colored to pale red, usually marked with brown. One annual brood, beginning in early summer. Incubation period is 26 days.	Food is largely plant material, such as buds, leaves, and wild fruits. In season, food may include insects and other small invertebrates. Excessive or crowded grazing by domestic sheep will disturb raising of family, and, of course, reduce the crop of young ptarmigan.	Unless timber-line areas are managed intelligently, this useful and interesting bird species is probably doomed to extermination. Birds may have some value as emergency food for lost or injured persons. Related rock ptarmigan is western, willow ptarmigan is eastern.
Nests on ground in early spring, often at edge of snowbank. Nest of grass, with soft lining. Eggs, 3-5, light drab to gray, uniformly spotted with different shades of brown, 1″ x ⅔″. Incubation by both sexes, but chiefly by female, 11-14 days. May have up to 4 broods a year but, normally, fewer.	Food is largely waste grain and seeds, but also includes many injurious insects, particularly cutworms. Is an exceptional destroyer of weed seeds. Horned larks are often found in large flocks that take flight as a unit when disturbed. Flight speed may be to more than 50 miles per hour.	Essentially a useful species, but may rarely feed on newly sown winter wheat. Role as destroyer of insects unquestionably compensates for damage done. Horned larks, rosy finches, and water pipits may constitute most of the conspicuous small bird population of areas of timber line.
Commonly nests above timber line on ground among grasses, or in a rock niche on a cliff. Grass lining in the nest, with moss, hair, and feathers. Bulky, but compact. Eggs, 4-6, of a nearly uniform brown, due to heavy spotting and with some related species laying pale blue eggs.	Often in great flocks at certain times of the year, flashing white-margined tail feathers nervously in flight, and often conspicuous on ground because of teetering habit. Sometimes may be in flock with horned larks, which have some habits in common. Have elaborate courtship flight.	Food largely insects, but may include small invertebrates that are not insects, and may also include seeds and fruits of a variety of plants. The bird is of no great economic importance, but a delight to bird students because of its cosmopolitan nature and interesting behavior, specially during courtship.
Nest is usually of fine grasses and roots, hidden in a rock crevice or on the ground. Eggs are usually 3-4, white. The subspecies may be closely associated in a common flock in winter, and at that time the birds may even visit city streets in considerable numbers. During breeding season, each goes its own way.	Food is largely small insects, including beetles, many of which may be blown uphill by strong winds to become benumbed and conspicuous on the snow, where they serve as food for hungry birds. In severest weather, finches may go below timber line to seek protection for the night.	Useful birds, living in a rugged environment and perfectly capable of surviving conditions that would be fatal to most of our common birds. They may serve as food for some predators. They are highly popular with ornithologists and others who visit their range in the proper season.

nature IN THE SCHOOL

In some schools, the pupils can see the timber lines of high mountains merely by looking out through their classroom windows. In other schools, the pupils must depend on books, magazines, and newspapers for their timber-line illustrations. Few pupils, however, have the opportunity to pay a visit to the actual timber-line territory, and to become acquainted with the climate, plants, animals, rocks, and weather to be found there. It is partly out of regard to the youngsters who may never be able to enjoy the offerings of the real timber-line territory that the main section of this special insert has been prepared.

During the summer vacation months, many Boy and Girl Scouts and other youngsters may have the opportunity to investigate timber-line country, and, as a rule, it would be time well spent. It is really not particularly exciting to view timber line simply by way of the printed page, and the same may be said of the possibilities, scenery-wise, of a fast-moving automobile. Timber line is always best approached through the medium of a perspiration-producing climb through timbered land.

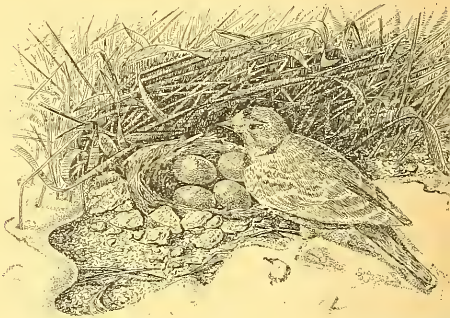
In some respects, a visit to timber-line territory is rather like a visit to the outer limits of snowfall at lower elevations in spring or fall. In spring, the snow near the student's home may be spotted with dark insects and other invertebrates. (The eighty-ninth issue of this series of inserts dealt almost wholly with such animals.) The student may see cabbage butterflies, or other butterflies, flying over early-spring snowbanks, just as he can see occasional yellow butterflies at the edge of the snow at timber line. He may find numbed flies, bees, or even spiders on a spring snowbank, much as they may be found at timber line during the early-morning hours of summer days. The lowland snowbank, in spring, may be marked by the tracks of horned larks, whose nests may even be found tucked neatly in a nearby tussock of grass.

Both the nest at timber line and the one beside the local snowbank may contain eggs, or even young birds. It might be suggested that, because of such points of similarity, if the student wishes to understand the natural activities of the timber line and above, he should be acquainted with those of the lowland snowbank.

Since the territory above timber line is usually exposed to strong winds, it might be well to study the animal activities of lowland hilltops, also. In such places, is there an abundance of loose, deep soil, or has the soil been washed or blown away? If it has vanished because of the action of wind or water, the pupil may better understand why there is often much loose rock above timber line.

If there comes an opportunity to study a locality that simulates timber-line conditions, do not be satisfied with investigating only that which you can see and feel without measuring instruments. Use a thermometer frequently and carefully, and notice if the differences in temperature at night and by day are greater than in forest or brush land. The student might also wish to study the water situation to see if the soil on the little mountaintop dries out more quickly than does that of lower levels among the trees. Such a study may aid in the understanding of the differences between low-country plants and those that live at timber line, or near it.

If the pupil lives in "hill country," he may notice
advance and retreat of the snow line on nearby hillt
and he may get some notion of the effect that alti
plays in relation to temperature—and, of course, its
sequent effect on the number of days in the year tha
free from freezing conditions. The latter consideratio
most significant in an understanding of the plants
animals of a given locality. Unless a plant or an
species is able to move about freely, it must be limite
areas in which there is a long enough growing seaso
complete breeding and development, and thus to gua
tee survival. All such observations may help the stu
understand the interesting timber line that is pict
in books and seen through the window—or, it ma
hoped, visited as opportunity offers.



Eggs or young of horned lark may be found near snowb

In the chart section there are several starred items
explanation, the references to teeth may include
letters I, C, P, or M. These letters refer to incis
canines, premolars, or molars. The numbers follow
as 4/4, refer to the teeth found in each category, with
first number referring to the number of teeth of that
on one side of upper jaw; and the other, to lower
Track symbols are letters like F, H, and Sp. These
to front feet, hind feet, and spread, with the number
ferring to the measurements of the tracks in inches.
number that sometimes follows these measurements i
cates the number of toes appearing in the footprint. "
refers to the spread between paired tracks, the meas
ments being made in inches.

In the cases of a few of the mammals in the chart
tion, I have included some quotations in rhyme. Th
are from a book on American mammals by D
Newell, published some thirty years ago. I think they
well worth including, as lending a touch of the colo
to those pages of the insert that must, by their nat
confine themselves to the strictly factual. I hope
readers will enjoy them as much as I did.

Dr. E. Laurence Palmer, for many years director o
Nature Magazine's educational program, continues hi
special inserts in the pages of the combined magazines

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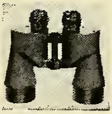

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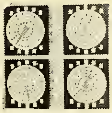

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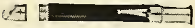

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The Awesome Bonebreaker

Quest for the myth-beset lammergeyer

By James Ferguson-Lees

Slowly, majestically, the huge bird dropped lower in the sky, not moving its long narrow wings but steadying itself with its wedge-shaped tail. Down below the tops of the mountain peaks it sailed, until it was almost lost against the gray limestone crags, fifteen hundred feet above us. It leveled out in a long glide at the very face of a cliff, and suddenly disappeared into a tiny cave. In a moment it reappeared: shortly after, it vanished again. Then it repeated this performance. There was no question now, we had at long last found a nest of the magnificent lammergeyer.

The lammergeyer, *Gypaetus barbatus*, is also known as "bearded vulture" or "lamb eagle" and is a creature with a fascination all its own. Perhaps no other bird in Europe has a background so muddled in legend and fact.

It is still little understood, thanks to its rarity and the remoteness of its mountain homes. It is nearly four feet long and has a wingspread of between nine and ten feet. Streamlined contours give the bird an appearance of speed and dash that is wholly lacking in its cousins, the broad-winged vultures. The lammergeyer seldom seems to move its wings. But, occasionally, it gives one powerful flap that brings the wing tips so far under the body that they almost touch one another.

But it was the bird's breast color that impressed us most—a rusty orange that gleamed like fire in the sunlight. The lammergeyer is mottled gray-brown on the back, wings, and tail.
The top of the head and back o
neck are creamy white. A broad b
mask starts above the outer edg
each eye. dips forward over the
of the beak, and ends in a tass
long, pendent bristles.

Standing watch for the lammergeyer, scientists take a precarious position on a rocky ledge to scan opposite cliffs in attempt to discover position of nest.

The lammergeyer's reputation
unfortunate. to say the leas
has been charged, for instance,
killing children and carrying them
Undoubtedly this myth arose bec
of the bird's great size. Actually
toes and feet are so weak that it
carry very little in this manner,
pending instead on its strong bea
also has been accused of thro
mountain climbers to their deaths
event not too unlikely should on
the huge birds unexpectedly fly

OUNG BIRD, still with immature feathers, will eat several ounds of meat daily. Birds of this species nest only in remote mountain areas through parts of Europe and Asia, but one subspecies lives at very high altitudes in Africa.

a climber with a precarious hand-old. Lammergeyers have, as a matter fact, been seen to sweep a goat or eep from its mountainside foothold its death, and then follow the victim own to feed on its carcass.

Like other vultures, the lammer-yer is a carrion-eater, but its favor- food is bone marrow. It carries rge bones high into the air, drops em to smash on the rocks below, nds, and picks out the marrow. From is habit comes its Spanish name of *uebrantahuesos* or "bonebreaker." ne ornithologist who found a lam-ergeyer's ossuary in Kenya, wrote: Over an area of some forty yards ch way the bare rock was littered ith white splinters of bone. In hol-ws they lay in drifts. I could have collected a dozen pailfuls." Only larger bones are treated this way; small ones are swallowed whole.

The lammergeyer nests in Africa and southern Asia, as well as in Europe, but it is not a common bird, and in Europe it is now decidedly rare, being confined to the Balkans, Sicily, Sardinia, Corsica, Switzerland, and three areas in Spain. It was to the last of these countries that our expedition set out in the summer of 1959 to find, study, and photograph the bird in one of the wildest sierras in all of Spain.

Our first days were occupied with trying to locate a nesting pair of lammergeyers, but several former sites—reported to us by shepherds and keepers—proved to be empty. We were getting discouraged when at last we saw a pair of the birds in flight. However, they lived at the edge of a valley several miles long and over a mile wide, and we searched for two more days before we spotted one big bird as it disappeared into the cliff face.

The next day we set out for the nest. The first few hundred feet consisted of a climb up a very steep slope. Fortunately, pack mules carrying blinds and other heavy equipment could accompany us on this stretch. When we reached the sheer cliff, the mules were

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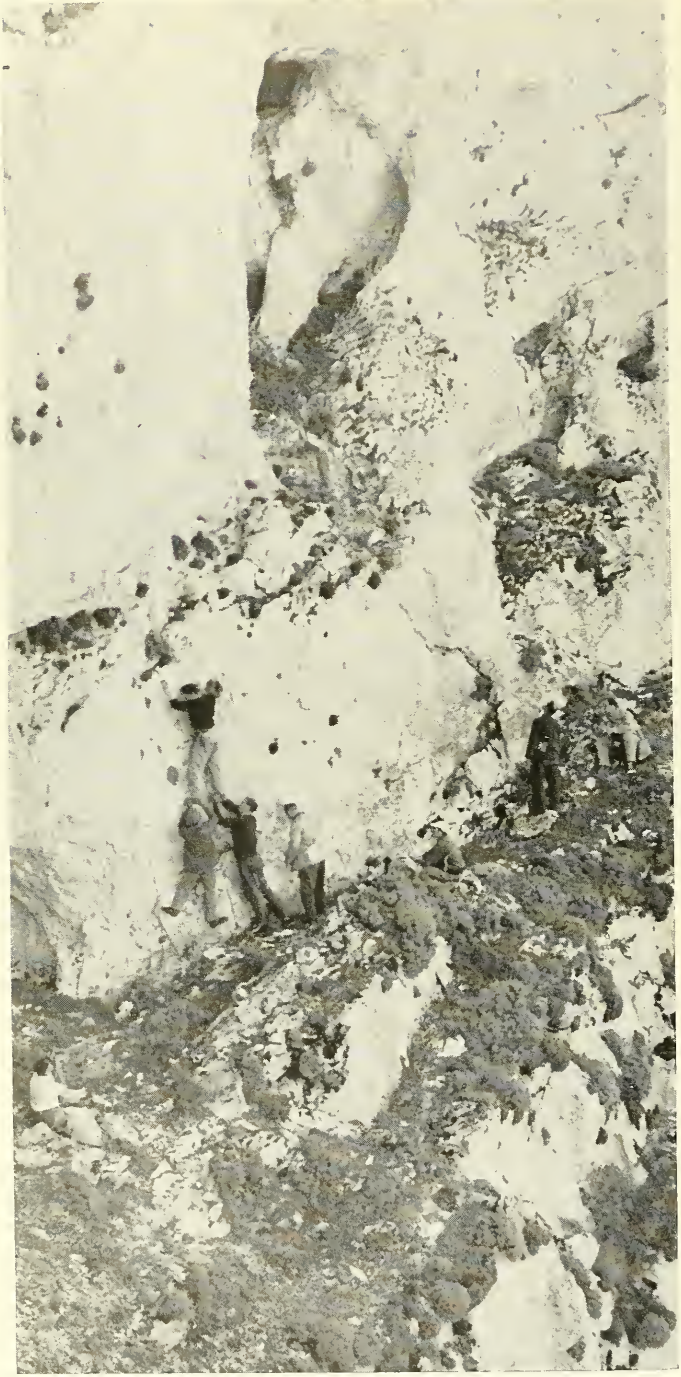
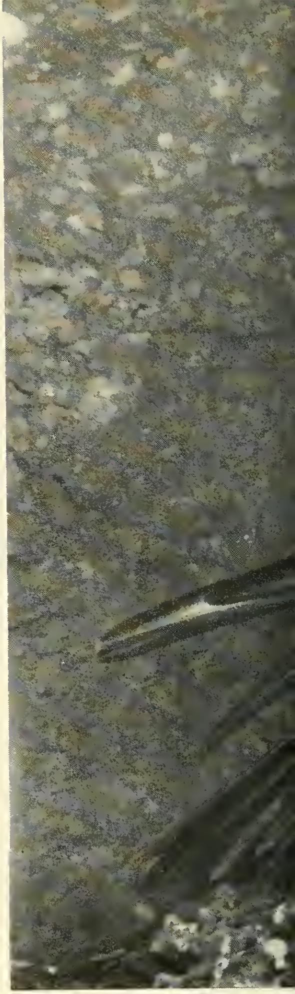
MR. FERGUSON-LEES is the executive editor of *British Birds*. He joined ERIC HOSKING, who illustrated this article, on the expedition to Spain in quest of the elusive lammergeyer.



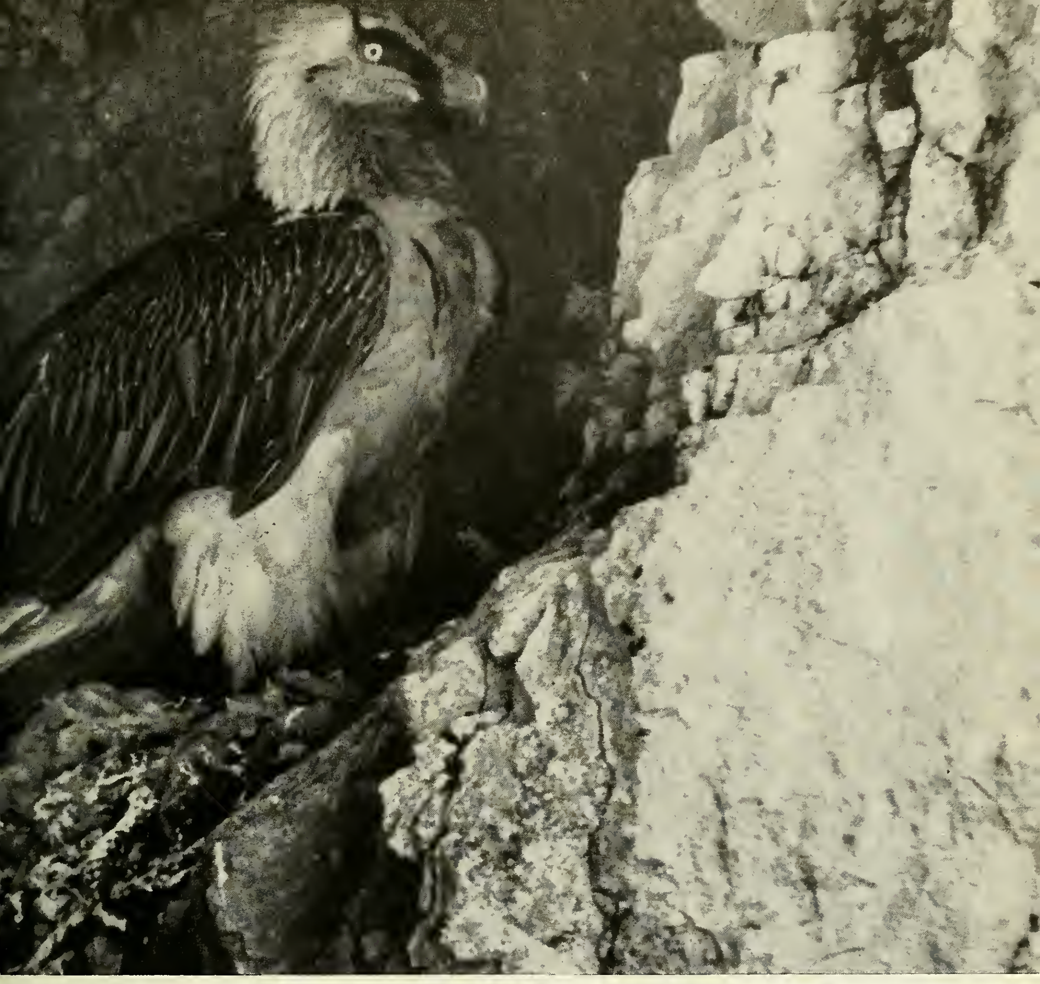
Ornithologists scale thirty feet of cliff that leads to nest in cave above them.

Until this point, equipment had been carried up mountain by pack mules.



left behind, and we gradually m
our way to a ledge about thirty
below the cave. This last section c
be scaled only with the aid of pi
and mountain climbers' ropes.

In the nest—a mass of big st
and wool—was a single grotes
and gawky youngster. appare
about two months old. The youn
most of our common song bird
in about a month from the time
eggs are laid; some in little more
three weeks. The lammergeyer, or
other hand, must incubate her on
two eggs for close to eight weeks
tend her voracious young for a m



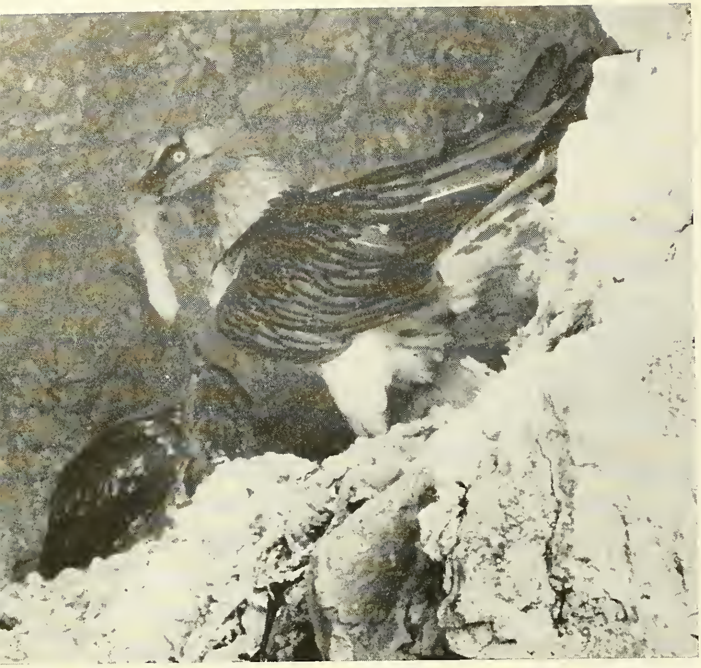
RAMATIC FEATHERING of giant bird includes a dark mask, hich ends under chin in tassel of bristles. Full feathers on legs is a characteristic of northern lammergeyers, while legs of the African subspecies are usually not feathered.

f three months or more. Lammergey-rs in Spain breed in the mountain nows of January and the young fly ut in the heat of June or July.

The single (or, rarely, two) young atches from a large egg, which can ary considerably in color. Some are hitish-yellow; others are brownish. lost are streaked or blotched. When irst hatched, the young lammergeyer s covered with grayish-white down. oon it is capable of taking in several ounds of meat a day and, because of ts excessive weight, can barely move. radually, dark brown and reddish eathers appear and by the end of two onths the bird is about two and a half feet in length, has a wing span of over six feet, and probably weighs around fifteen pounds.

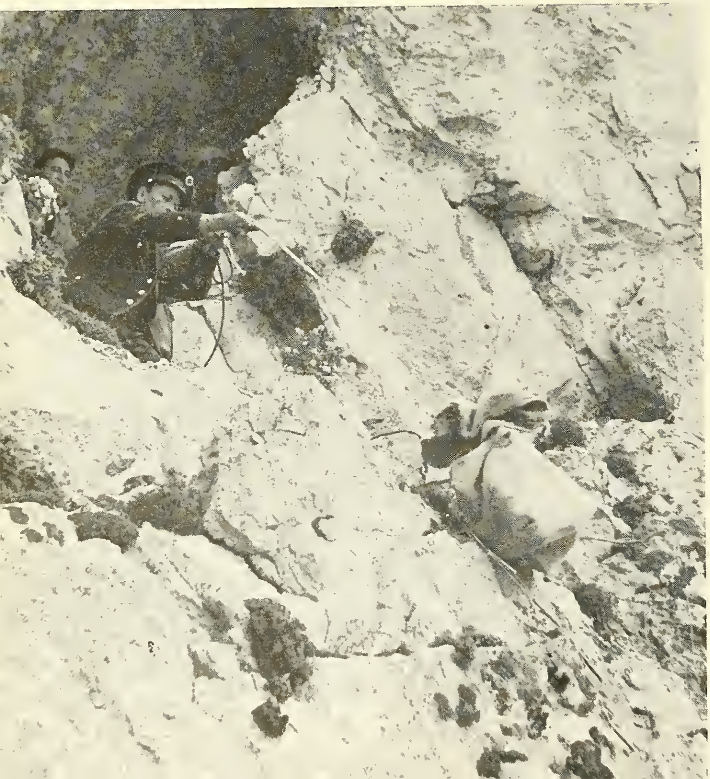
Our young lammergeyer was put in a sack and lowered carefully to the ledge below, so that it could be photographed. It was not an easy baby to hold, and fought vigorously with its three-inch beak and sharp talons. In the parental nest were two sheep's legs, a donkey's hoof, a number of goat bones, and a dog's skull. There was also an old rope sandal. Such a collection of bones is typical of the bird's nesting material, rather than of any killing tendencies.

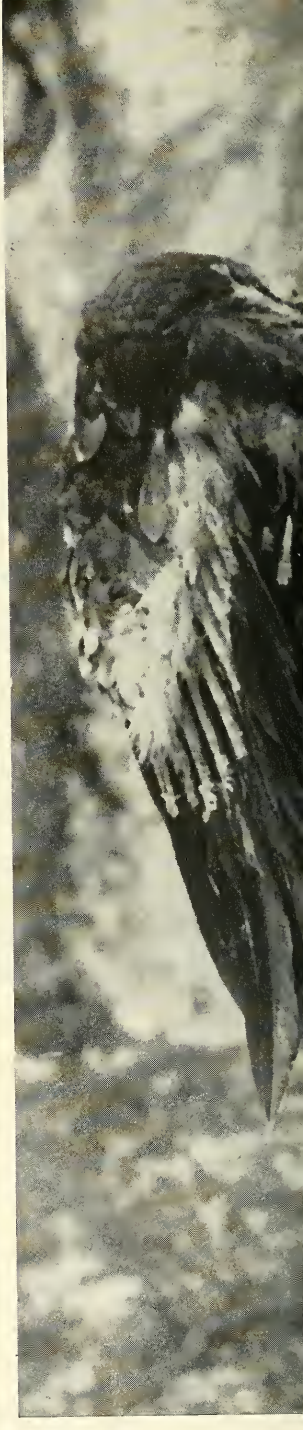
The grace of this mountain dweller, as it follows the major contours of a rock face or soars high over ravines, is beyond description. To country people in its native lands, the lammergeyer will undoubtedly always be feared as a menace—a vicious predator, a sheep-stealer, and a man-killer. Yet for all its might it is afraid of its vulture cousins, and waits until they have finished picking a carcass before coming down to feast upon the stripped and bloody bones. One authority has even said, with a certain sadness of tone, that the great creature is so cowardly that even a puppy dog can frighten it into flying away.

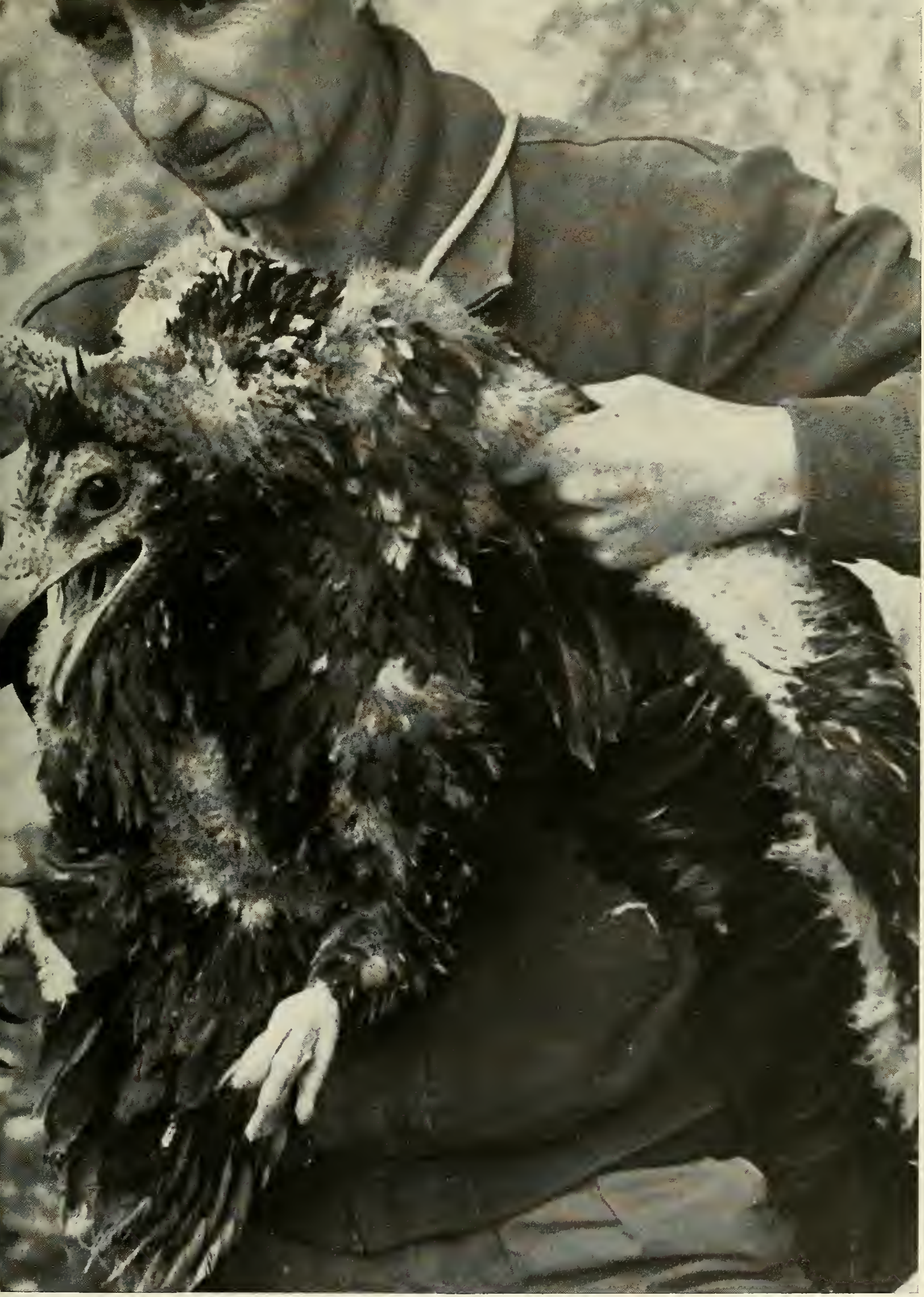


Parent usually has one young in nest made of branches, bones, and fur, *above.*

Nestling, *below,* was put in a bag and brought down to study and photograph.







INGSPREAD of young lammergeyer is about six feet and, hen bird is fully grown, may reach nine or ten feet. Its fierce-looking talons are actually remarkably weak, and so belie the myths claiming that the birds carry off children.

Banana tree shades a village Negro, in skirt, *left,* and visiting Pygmy helper as they husk rice in wooden mortar.

Chores on plantation of wealthy Negro, *above,* are done by Pygmies, who are given food and utensils in exchange.

PART II

Children of the Forest

Economics and ritual link forest Pygmies with village Negroes

By Colin Turnbull

The BaMbuti call themselves the Children of the Forest with good reason. They live in close harmony with their environment (See Natural History, August-September, 1960). They make their huts of forest-cut saplings, and cover them with forest leaves; they have a wide choice of lianas and trees from which they can make bark cloth to dress themselves; there is ample deadwood for the fires that cook their forest game and keep them warm at night. Above all, the forest allows them time to relax and enjoy themselves; for the adults, this means singing and dancing.

Yet, at the root of this apparently free and easy, unsystematic adaptation to a generous but limiting environment there is in fact a system and a central authority—the forest itself. This hidden authority is most strikingly evidenced in the relationship between the indigenous forest dwellers, the Pygmies of Africa, and the various Bantu and Sudanic tribes who, three or four hundred years ago, were driven into the forest—bringing with them, for the most part, a plains culture — where they cleared land to set out plantations of bananas, cassava, rice, maize, and beans.

It is essential to understand not only to what extent the Pygmies are adapted to their forest and depend on it, but also the extent to which they love and trust it—with much the same affection that children bestow on their parents. Earlier I told of a youth, a flower in his hair, "... dancing to the Forest, dancing to the Moon." This is but one indication of the attitude these

Picket stockade, behind which is a group of five or six houses belonging to members of one family, reveals the real and imagined fears of the Negroes, who believe that if are shut away from other villagers, they are safe from h

simple people take toward the world around them: there are many more. If we understand this attitude, it is not hard to see how the BaMbuti first reacted (and still react) to the invading Negroes—whom the Pygmies often liken in their legends to the clumsy, great elephants that destroy the forest in order to live.

When the warring Negroes first arrived on the scene, they made use of the Pygmies as guides, spies, scouts, even as mercenary soldiers. Caught between a number of mutually hostile Negro tribes, the Pygmies had little choice in the matter. While acting as ancillaries, they had no time to hunt and gather, and came to rely on the products of Negro plantations for at least a considerable proportion of their food. When the Negro tribes became more settled and warfare was finally stamped out by the Belgians, this relationship came to an end.

The Negroes, now at peace, no longer had any need for the Pygmies. But the Pygmies had developed a strong taste for plantation food and still demanded to be fed. Each Negro tribe continued to give food to "its" Pygmies. In return for this, the Negroes expected a new service: meat from the forest. There has never been any fixed rate of exchange. If at any time a Negro is reluctant to give a stalk of bananas in return for the dubious possibility of getting some meat at a later date, the Pygmy simply to the plantation and steals the nanas. The Negro, on the other h is not a hunter, and does poorl securing meat if he is left to rel the traps and pits he may put in forest near his plantation.

The present situation, then, is of ambivalence. Neither group pends on the other, but each finds other convenient. The Negro meat and forest honey, and he lik

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This is the second of two reports the Ituri Forest Pygmies, with wh the author lived during three tri to Africa. Mr. Turnbull is now the staff of The American Museu

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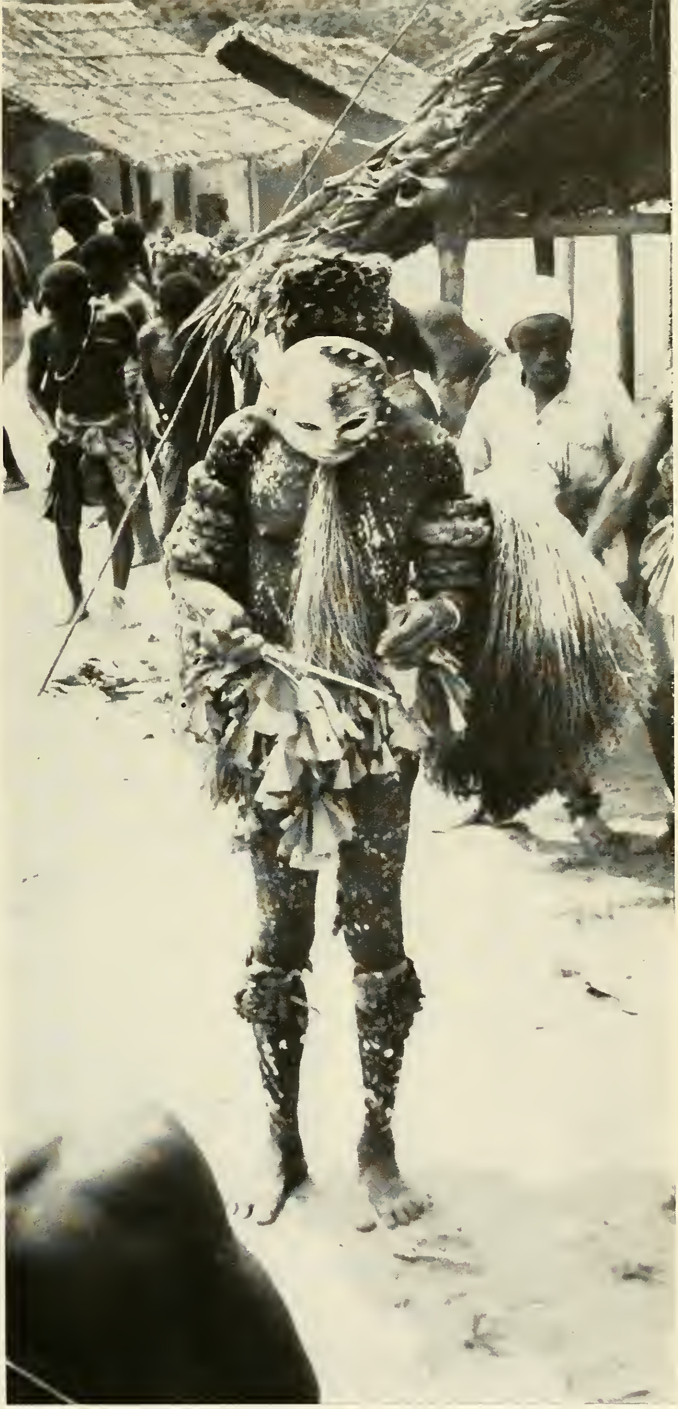
able to get the various woods, rks. saplings. leaves. and vines that needs without having to go into the rest himself. He attempts to get the gmy to do these chores for him in change for plantation foods, as well for the metal and cooking utensils which the Pygmy increasingly re- s. The Pygmy accepts what he is ven. or helps himself, and performs e chores he feels inclined to—but thout any sense of deep obligation.

THE Negro tries by various means to assert his authority and for- alize the relationship: outwardly, he pears to succeed. There is scarcely Negro village in this whole area of e Congo that cannot produce at least



MASKED DANCER leads Negro initiation rites for boys. Influence of Islamic culture can be seen in the headgear worn by Negro at the dancer's left.

Negro ritual is followed when Pygmy wedding occurs during a village visit.

a few Pygmies any day of the year, and explain their presence as "servants." All Negro chiefs and headmen claim to "own" so many Pygmies, whose progeny they inherit and pass on, at death, to their sons. This claim has given rise to the myth that the Pygmies are the hereditary servants, if not the slaves, of their Negro masters. But this is only an attitude—nothing could be further from the truth. And it is certainly not the attitude of the Pygmies toward the situation.

When a Pygmy hunting group feels like a change from the forest—perhaps some palm wine to drink and tobacco to smoke—or when the hunting is not particularly good and the chase has taken them nearby, such a group will descend on a Negro village; usually the one nearest to the Pygmies' hunting area and the one where these particular Pygmies have already established individual and group relations. They camp at the edge of the village and bring in gifts of meat, honey, firewood, or whatever else they may have to spare. They receive plantation foods in return.

But as soon as the Negroes begin to apply any pressure, or as soon as the Pygmies get tired of the village, nothing will stop them from packing up and returning to the forest. The Negroes, unable to move about as quickly and silently as the Pygmies and not knowing the forest trails so well, are unable to pursue them. Any authority that the Negro wants to assert has to be something other than sheer force. So he encourages the Pygmies to adopt Negro tribal customs and to subject themselves to certain rituals. In this way, he is attempting to subject the BaMbuti to the supernatural, the ultimate authority of Negro tribal lore. And as the Negro is *de facto* the only one qualified to perform these rituals, this makes the BaMbuti still further dependent. O
it would seem at first glance.

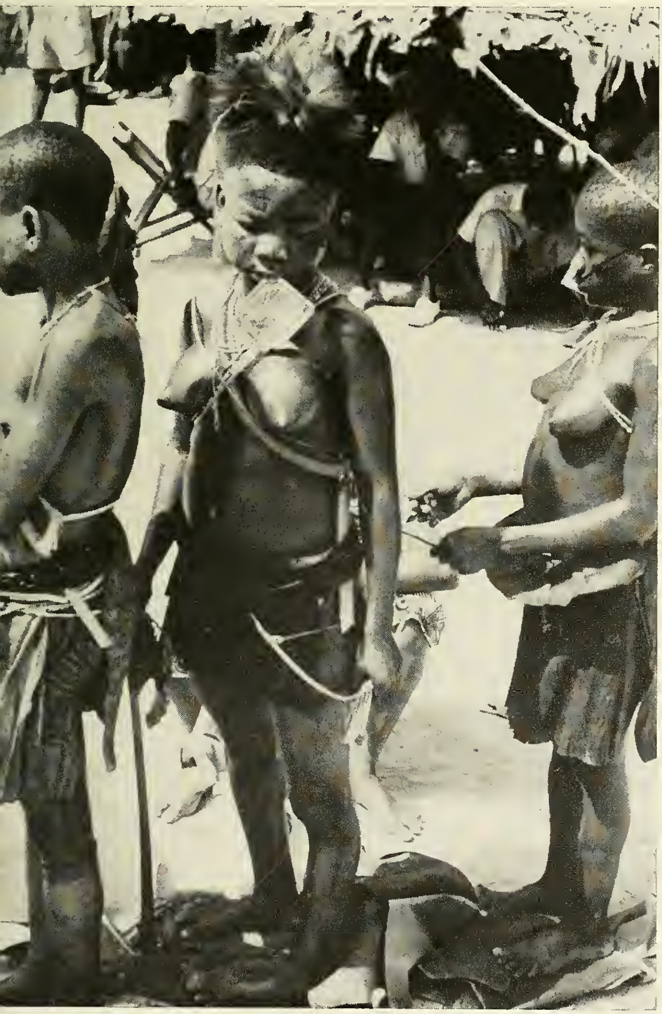
To all of this, the BaMbuti sub
generally enjoying the festivity—e
the ritual feasting involved in a de
and the subsequent witch hunt. Bu
any suggestion that sorcery was
volved in death they react without
thusiasm. To the Pygmies, death
perfectly natural phenomenon, to
greeted without particular desp
dency when it comes to a person
is too old to enjoy life or to a c
too young to have savored life's pl
ures. Only when death strikes some

Sister of the couple's "patron," despite her "superior" position, fans vine-tied banana leaves on which Pygmy b
will stand during wedding cerem

n the prime of life is it any cause for ygmy concern and, even then, the nly suggestion that sorcery or witch-raft has been its cause will come from he superstitious Negroes.

IT may well be asked just what the Negro gets out of all this patronage f Pygmies in return for the time, rouble. and expense involved. What e hopes to get. anyway, is authority. n particular, he tries to invoke the id of his tribal ancestors by going to he extreme of admitting young male ygmies to Negro tribal initiation ceremonies, and initiating them along with Negro boys of the same age.

This initiation ritual, known as the *nkumbi*, takes place about once every three years. It involves the circumcision of boys between the ages of nine and twelve. The *nkumbi* signifies for the Negroes the symbolic death of the child as such, and his rebirth as an adult member of the tribe, instructed in tribal lore and subject to dread penalties (to be inflicted by the supernatural) if he transgresses the laws or divulges the secrets that he has now learned. The children spend several months away from any contact with the village, the women, or other uninitiated youngsters, and are strictly disciplined and instructed. At the end of that time, they are paraded through the village and introduced as adults: from that moment, they assume adult privileges and responsibilities.



YGMY BRIDE holds gift of five-franc ote in mouth. Attendant at right holds bride's bark cloth belt with two sticks, showing she still belongs to her family.

SLOW-PACED PROCESSIONAL of wedding party continues through the entire day.

When Pygmies are included in the ritual, they are often circumcised alternately with Negro boys. Each couple initiated in this way is bound by a special bond of mutual obligation and friendship. This helps strengthen the ties between the two peoples, but always the Pygmy is carefully placed in an inferior position. For instance, he is cut first, "to clean the knife." Although the Pygmy is then considered an adult and is able to join the Negro men in their village *barazas*, he is still *not* a member of the tribe and thus cannot become a ritual specialist in Negro tribal lore or conduct any of his own ceremonies.

THE Pygmy is perfectly content with this, because none of these ceremonies, the *nkumbi* included, has the same significance for him that it has for the Negro. This was made very clear to me on one occasion when the *nkumbi* had to be performed—as it must be at regular intervals—and there were no eligible boys but Pygmies.

Celebration dance is performed by Negro women before the beginning of boys' initiation rites. Dance is traditional, and is accompanied by sticks clapped together. Performan may continue for more than a week, while relatives gath

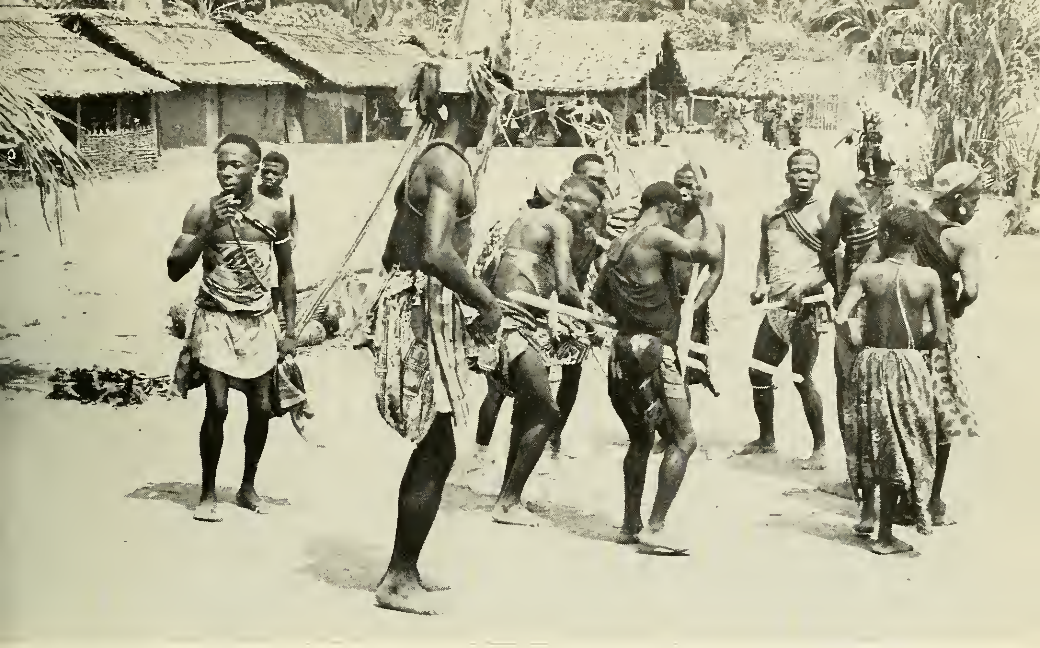
The Negroes tried hard to find at least one eligible Negro boy, but were not able to do so. They went ahead with the ceremony—the sole participants being eight Pygmy boys. The ritual was conducted exactly as always but, by the Negroes' own rules, only relatives of the boys to be initiated were allowed to stay in the initiation camp overnight. This meant, of course, that no Negroes were allowed to stay. They sometimes made short visits to see what was going on, but that was all they could do without risking supernatural punishment.

This circumstance gave me a chance to see the real attitude of the Pygmies, which was revealed significantly in the evenings, after the last Negro had left camp. During the day the boys, their fathers, and their elder brothers observed all the Negro restrictions on behavior, ate only prescribed foods, and paid due reverence to certain sacred objects (including a banana) hung from the roof of the initiation hut. If rain threatened, the boys all took shelter, because it is believed—by the Negroes—that to get wet at this time will bring death. For this and other reasons, the boys were not allowed to wash, and were daily smeared with white clay. At the sound of the bull-roarer, the boys cowered in apparent terror.

But in the evening, when the Pygmies were left to themselves, the boys would leap off their beds, join the elders around the fireside, eat all the prohibited foods, play punch ball with the sacred banana, and openly mock all the other taboos. It was made quite clear that, for the Pygmies, the *nkumbi* held no magical or religious significance at all. They were not in the least concerned with the supernatural world of the Negro; they did not fear it and they wanted no part of it. They appreciated the fact that the strenuous discipline prepared their boys for the responsibilities and hardships of manhood but, even more important, they recognized that it put them on a footing of greater equality with the Negroes. To the Negro, an uninitiated male is a child, and is looked down on. The Pygmies are a proud people: they felt that, by undergoing the initiation, they were able to prove themselves equals in manhood to the Negro boys.

Upon following the BaMbuti back to their forest home after such a period in a Negro village, and in livi with them there, I found the situati appearing in its proper perspecti The customs that the Pygmy adopts readily in the village, giving him t appearance of an acculturated produ (the sophisticated, French-speaki Africans refer to the Pygmies as *gens sans culture)*, are dropped though they had never existed. Bir marriage, and death are met with ch acteristic Pygmy indifference to p sible supernatural significance and t necessity for ritual protection. A m riage that has taken place under Neg auspices is regarded as no more th a flirtation until it has followed t traditional Pygmy pattern of exchar visits and reciprocal gifts. Still m significant, the initiated youngster who are accorded adult status in t Negro village—are still regarded children back in their hunting ca They return to their mothers, and certainly not allowed to take part purely adult affairs. By the BaMbu they are not considered men until t have killed some large game, provi themselves as hunters capable supporting a family and helping support the group as a whole.

There is more than a mere dropp



ILLAGE MEN begin initiation ritual by cutting series of ticks of various lengths. Each one has a different "tone" and, together, make a portable xylophone. Sticks are always played in concert and are basic part of initiation music.

f Negro custom and ritual. The care-ree attitude the BaMbuti assume in ie Negro village—showing no sense f moral obligation toward the Negro, mploying themselves for their own idividual pleasure and amusement—, also dropped. The Pygmies still feel o sense of moral obligation to their legro neighbors but, once back in the orest, their existence as part of a co-perative group takes precedence over ieir existence as individuals or indi-idual families. They still retain their nmense capacity for enjoyment of fe, but it assumes a more sober form, iore directly related to their forest fe and the reinforcement of forest alues. Song, mime, and dance, the hief forms of Pygmy adult recrea-on, provide the most important in-ances of this relationship.

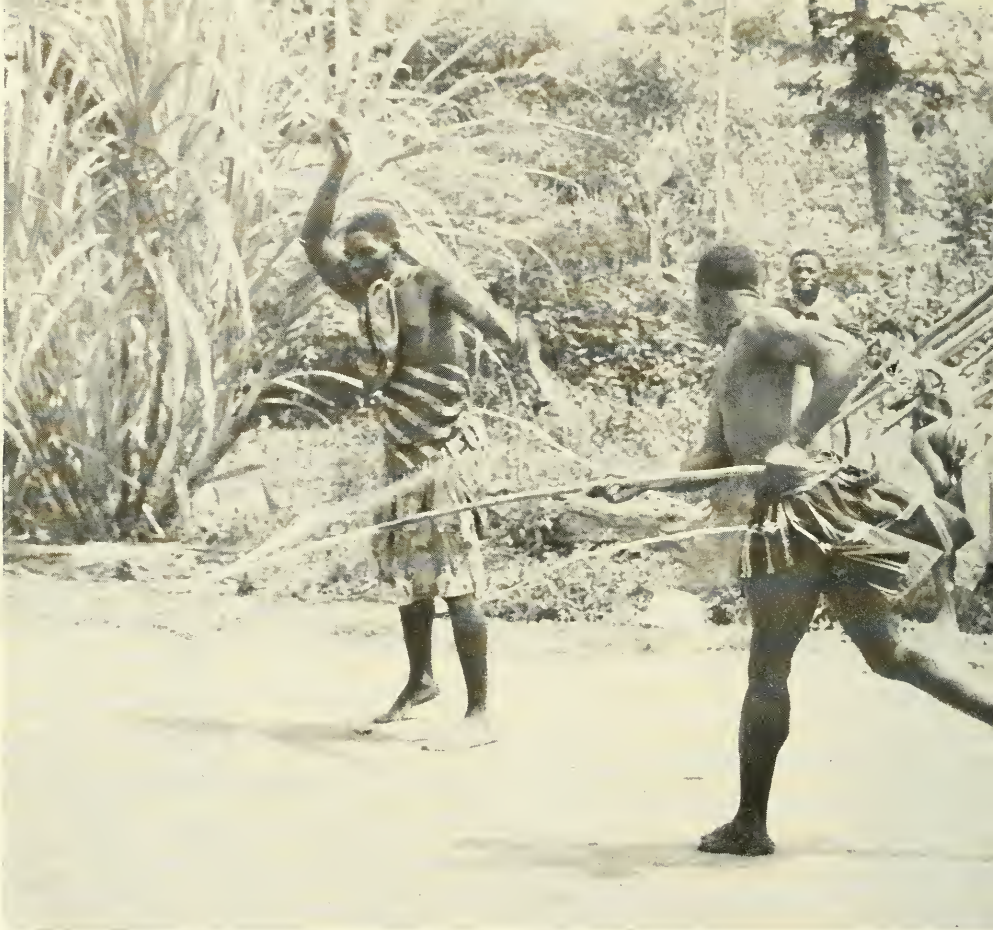
N the Negro village, the Pygmies borrow drums and dance wild, rotic dances, to the delight of the vil-igers. But they never sing their forest ongs. They pick up Negro musical istruments and play these, and some-mes sing with them, but what they ing is always a Negro song. In the orest, if the hunting camp is near a illage and someone has managed to make off with one, a drum may occasionally be heard, but the effort is never serious. Forest music is purely vocal: tapping sticks provide sufficient rhythm for their purpose.

In the forest there is no counterpart of the village dance. Here the Pygmy dances are all associated with forest life, mainly with hunting and gathering activities, as are their mime, their *molimo* songs (the sacred songs of the great hunters, in which only adult males are allowed to take part), and the corresponding songs of the adult women. In a sense, all forest songs are sacred: all of them are to a greater or lesser extent in praise of the forest, and the forest itself is sacred to the BaMbuti, who recognize it as the giver of life, the source of all well-being.

The fact that the BaMbuti will not sing their forest songs in the village is an indication both of the sanctity of the forest and of the Pygmies' attitude toward the Negro village. This may, on the surface, seem a trivial point, but in fact it is the most vital factor in the life of the BaMbuti—dominating not only their everyday life, but also their relationship with the Negro tribes around them. For music is the mainspring of the Pygmies' religion.

AGAIN, the environment helps us to understand the contrast between forest and non-forest peoples. To the Negroes, who are people from the plains forced unwillingly into the forest, this world is harsh and hostile, dark, gloomy and full of hidden dangers, real and imagined. In their everyday life they find themselves continually brought up *against* the forest. It is hard work to clear their plantations, and then the Negroes have to fight a continuous battle to prevent the plantations from being overgrown. Under such conditions, the high incidence of magic, witchcraft, and sorcery is not surprising. The forest is regarded as a source of misfortune, a place peopled with evil spirits, something to fear and to guard oneself against with the greatest care.

But for the Children of the Forest this world is kind and good, always cool and fresh, supplying all their needs. As far as they are concerned, the dangers of life are few, and they have no reason to suspect the presence of malevolent spirits. The normal cycle of their life throughout the year—and from year to year—bears out their belief that the forest takes care of its own. Witchcraft is unknown to them;



Adults—in this case Negroes—slash at each other with long saplings, *above*, such as are used for building their houses.

Ceremony symbolically "strengthens" boys for the ord
and the drama is heightened by whips' loud cracking no

Whips, now broken, are stuck in the ground, indicating boys are strong. At their base are piled gifts of food for all the initiates and their families.

sorcery—the notion that one can w
someone harm—is a concept utte
abhorrent in their eyes. Such li
magic as they possess is of a sim
sympathetic nature, based on
closeness of their identity with
forest. It is not aimed, as is Ne
magic, at opposing and changing
natural current of events but, rath
at stimulating it.

In times of crisis, the two peo
react very differently. The Negro re
tion to trouble is the immediate be
that someone—or some spirit—is ca
ing the misfortune by witchcraft a
when located, must be punished, p
fied, or placated. As life for the Ne
is filled with misfortunes, it is a
filled with accusations of witchc
and sorcery. And magic is continu

Pygmy father comforts son who cried while being circumcised. Negroes would consider such weakness a great shame, but Pygmies actively dislike brutality.

eing invoked to ward off all manner f incipient evil-doing.

WHEN crisis strikes a BaMbuti hunting group—in the form of ad hunting (which is rare), serious lness (which is also rare), or the eath of someone in the prime of life -the attitude is not one of suspicion, ear, or hostility, but rather of anxiety iat something has gone awry in their ormally good world. Being a practi-al people, the Pygmies' reaction is practical one. All these occasions emand only one thing—that the adult iales gather together and sing. I once ad this explained to me by an old 'ygmy in very few words: his ex-lanation has been borne out many a ime in subsequent observation and

After initiation, boys are dressed in bark cloth, belts, and beaded necklaces, and paraded in front of the villagers. Entire ceremony is in Negro tradition.

Pygmy workers help construct Negro house, *above*. Negroes also depend on Pygmies for meat and forest honey, for wood-cutting and water-carrying. Thus, reciprocal relationshi are founded on both economic and ritualistic association

discussion. He said: "Our life is good because the Forest is good. it gives us everything we want. If something goes wrong, it must then be because the Forest is asleep and not watching over its children. We sing our *molimo* songs because the Forest will hear them and awaken, and all will be well again."

There is no need to ask the forest for this or that, because the BaMbuti believe implicitly that a good, satisfactory life is normal: so long as the forest is awake and watching. all will go well. They are content to let the forest decide what is best—their job is simply to awaken it. And this is done in one of the most beautiful rituals, if it can be called such, that one may imagine—a form of communion between a people and their deity that contrasts sharply with the superstitious beliefs of the Negroes.

This ritual, known as the *molimo,* involves all adult males. The first step is to collect firewood and food from every Pygmy hut, thus emphasizing that the *molimo* concerns the group as a whole. In the evening. the men sit around a special fire until the women and children go to bed. Then the men start singing the *molimo* songs, never using drums but only the *banja,* split sticks that are tapped lightly together. There may be one or two mocking songs while the women and children are still awake but, after that, the tone changes. The songs become serious; quiet but intense. After a couple of hours there is a short break, and the men eat the food that has been cooked on the *molimo* fire. Then the singing starts again, with greater intensity and increasing volume. The songs vary a great deal in mood: some are reflective, others see to be the expression of pure joy. B all moods are represented. regardle of what the occasion may be.

At a certain point. if the situati is a very serious one. the singers w stop and listen. From far off in t forest they will hear their song echo back to them, and they renew the efforts. One of their number—usual a young man, but always a good sing —has gone into the forest a distan from the Pygmy camp and, as h fellows sing. he picks up their son echoes it into a long. wooden trump and passes it on deep into the fore so that the forest is sure to pay atte tion to the plight of its childre The singing thus becomes a deep personal, yet still a co-operative co munion between the BaMbuti a their forest, which is their god.

None of this will take place when the ygmies are in a Negro village, and one of it even in the forest if there appens to be a Negro visiting the ygmy camp. Before the *molimo* singng starts each evening, the trails to he village are ritually closed with allen branches or logs. This is somehing that concerns the BaMbuti and heir forest god alone, and the proane, non-forest world must be entirely xcluded from the communion.

THE Pygmies are fully aware that village ways have no practical pplication or value in the forest. At he same time, the very vigor and self-onsciousness with which they reject illage values perhaps indicates a ense of guilt or infidelity with regard o their forest life. There cannot be ontact between the two people with-

CLOTHING, for which a Pygmy is being measured, *above*, and salt fish, *below*, are luxuries Pygmies buy with the wages they are paid by their Negro employers.

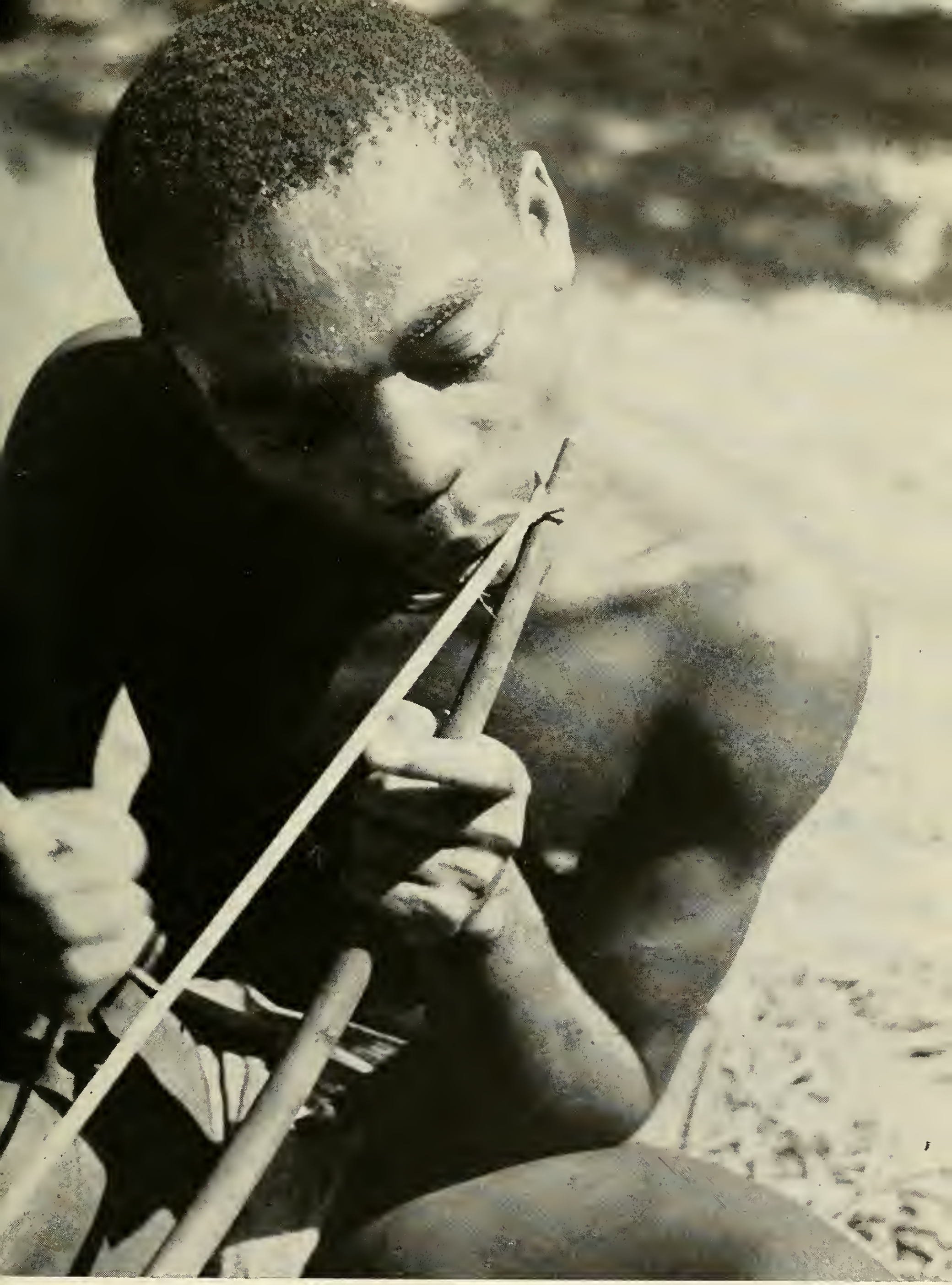
Hoop dancing, with which Pygmy girls amuse themselves in streets of Negro village, is a complex version of rope jumping, employing bent piece of vine.

out some degree of acculturation, so
common level at which this cont
can successfully be made.

THAT is what the BaMbuti are t
ing to resist by dividing the t
worlds in which they live, and ke
ing them rigidly apart. They are co
pelled to do this both by the knowlec
that they are Children of the For
and can never survive outside it. a
by an acute awareness of the hostil
of the Negro to the forest, and
apparent hostility of the forest to
Negro. The only possible reactio
and the only possible relationship th
could have with the Negro—is one
opposition and resistance.

While the Pygmies are still able
hunt and gather, they will still
BaMbuti, the Children of the For
But once this is impossible, they
become those miserable caricatures
their Negro neighbors that they
already so often and so wrongly
lieved to be. And it has already b
seen that, once taken from the sha
of the forest, they quickly sicken a
die. It is significant that the *molim*
which once almost certainly was o
a ritual of individual Pygmy hunt
groups, faced with particular, lo
problems—is more and more assu
ing a "pan-Pygmy" aspect, concer
not only with internal problems
also with the broader challenge
maintaining BaMbuti forest integr
against the machinations of the n
forest peoples who surround them.
is difficult to see how there can ever
any reconciliation between the two
am very much afraid the BaMbuti
correct. They themselves say: "Wh
the Forest dies, its Children die."

Native rubber makes balls used h
by Pygmy boys playing a kind of socc



ADAPTING HUNTING BOW to jew's-harp, boy blows on string while tapping it with arrow. Sound is melodious, but range is limited. Until he returns to his beloved forest, Pygmy refuses to play songs relating to his people's ceremonies.

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FACE FACTS: the first of October is by no means as comfortably distant from the Yule as it may seem.

But we have a simple suggestion, and one that — if acted upon — will bring kind recollections of your holiday thoughtfulness throughout the whole year ahead.

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Who knows better than yourself, by the honored rule that the proof of any pudding is in its eating, that the pages of this magazine bring to each reader a fresh delight in the whole, great realm of nature? These insights and understandings — adventures of the mind along the varied frontiers of today's science—can be your welcome gift to any (or many) of your friends this Christmas.

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Much as we love children (and supscriptions), we must in candor declare that none but the especially bright youngster under sixteen is likely to enjoy the magazine.

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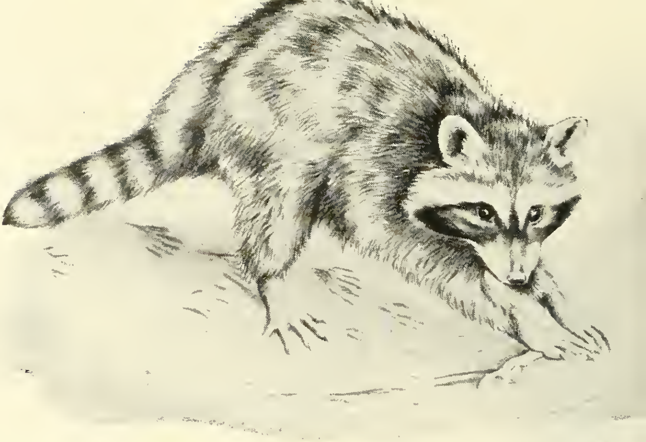

Raccoon, *The Wild Mammals of Missou*

REVIEWS *(Continued from page 6)*

tinent management data. In the case of the mammals, drawings of skulls are included as well. With only minor exceptions, the author has followed the current authorities with regard to taxonomy.

Largely because of its strategic location at the juncture of the Nearctic and Neotropical zones and its varied topography, Mexico has a large and varied fauna. We are only just beginning to understand it. In Leopold's own words, "... this whole volume strikes me as a sort of monument to how much we do *not* know about Mexican wildlife." Be that as it may, it is a significant contribution and has already received acclaim among professional circles. *Wildlife of Mexico* was selected by the Wildlife Society as the best volume in the field of wildlife management and conservation published during 1959. It will undoubtedly stimulate much needed additional investigation and will continue to serve as a useful guide for sportsmen and amateur naturalists and as a valuable reference volume for professional ornithologists and mammalogists for years to come.

WESLEY E. LANYON,
THE AMERICAN MUSEUM

THE WILD MAMMALS OF MISSOURI, by Charles W. Schwartz and Elizabeth R. Schwartz. *Univ. of Missouri Press and Missouri Conservation Commission, $5.95; 341 pp., illus.*

The Wild Mammals of Missouri is a book that belongs in every naturalist's library. Excellently illustrated, well written, and accurate, it should serve as an example for writers and illustrators who wish to produce a book on mammals for the amateur.

The introduction includes information on the characteristics of mammals, their habits in Missouri, keys to their identification, and a list of the wild mammals of the state. This is followed by chapters on
each order, with a key to the specie
both by external appearance and by us
of the skull. The species accounts sta
with an explanation of the scientific an
English names of the animal and are fo
lowed by a description that includes i
formation on color, size, teeth and skul
sex and age criteria and ratios, gland
voice, and sounds. The distribution i
North America of each species and i
abundance and distribution in Missou
is given, and a detailed description of th
habits, home, and habitats follows. Foo
is discussed, and reproduction, mortalit
factors (under the caption "Some A
verse Factors"), economic and ecolog
importance, management and contro
and selected references make up the r
mainder of the account.

Combined with the species accoun
are some of the finest black and whi
illustrations we have of North America
mammals; they were done by Charles
Schwartz, who also illustrated A. Stark
Leopold's *Wildlife of Mexico.* A ful
page plate, containing a view of an enti
animal, details of the sole of its front a
hind foot, and views of its skull, acco
panies the account of each species. The
plates also include details of teeth, ea
feet, and skull, when such are needed f
identification. Smaller illustrations
the text show tracks, burrow system
young, and scenes from life.

The authors have avoided technic
terminology yet preserved accuracy
superbly blending illustrations with te
The book is economically written but
eminently readable, and the authors a
to be commended for the production
the finest state mammal book of its kin
The residents of Missouri are fortuna
to have this work available; naturalis
in other states will find the book we
worth purchase—particularly at the re
sonable price at which it is listed.

RICHARD G. VAN GELDE
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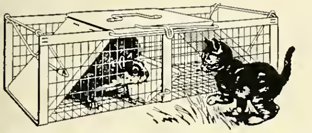

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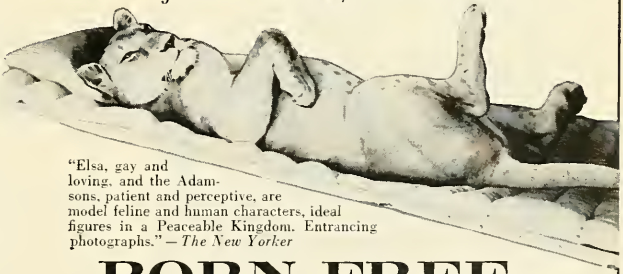

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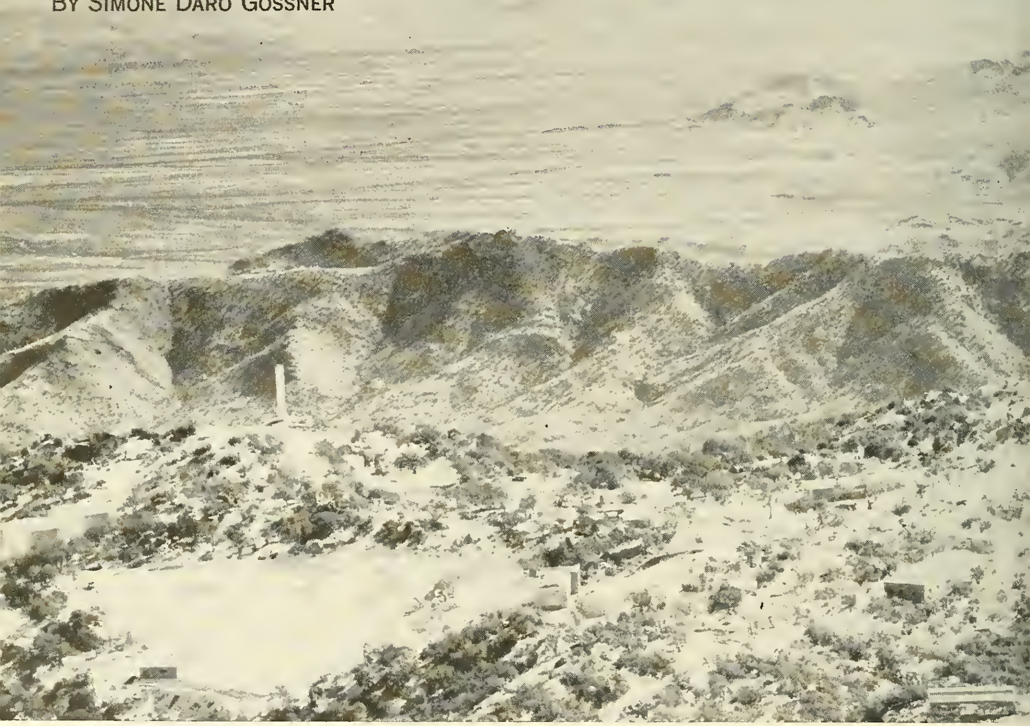
SKY REPORTER

By Simone Daro Gossner



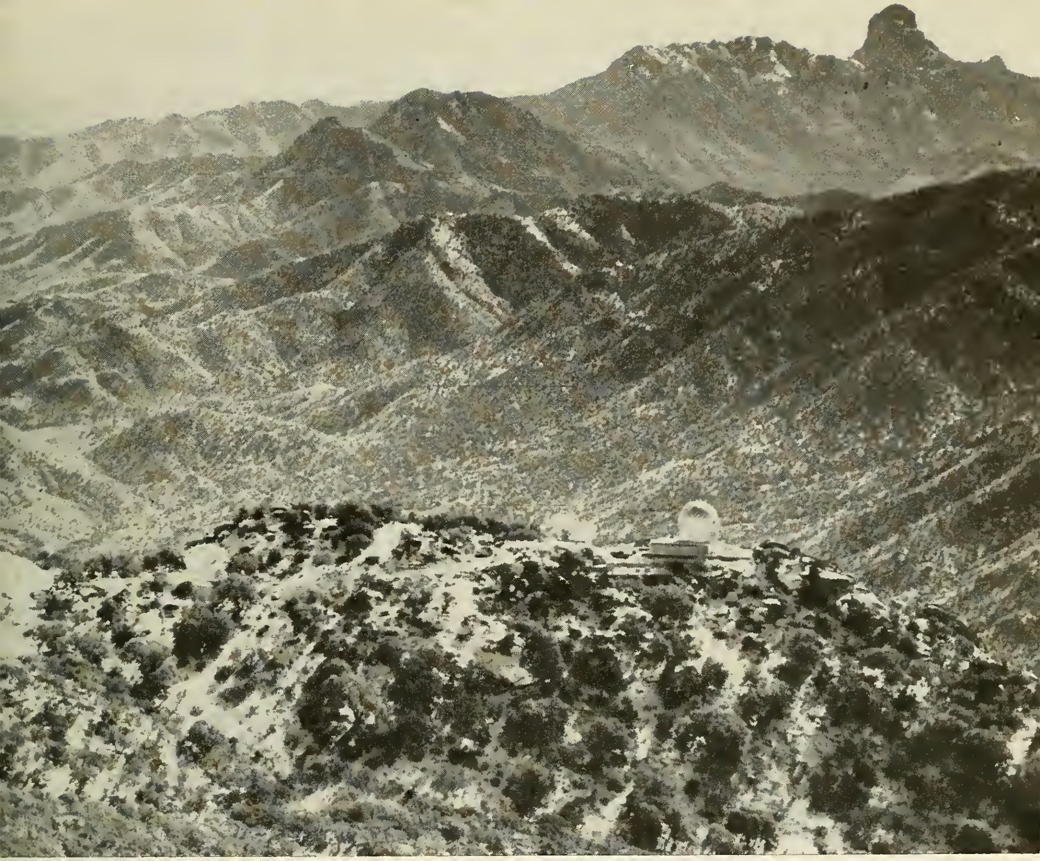
Air view of Kitt Peak shows complex of dwellings, *center,* and one of two 36-inch telescope housings, at extreme right.

Observatory's largest telescope, an 80-inch instrument, will be housed in building seen under construction, *above.*

Our National Observatory ato a Holy mountain near Tucsor

The Papago Indians of Arizona have been friend to the white man for more than four centuries. R cently, they have been called upon to co-operate with hi in a project, which is doubtless unique in their histor Their reservation, in the midst of the Sonora Desert, i cludes the massive mountain known as Kitt Peak (6,8 ft.), forty-five miles southwest of Tucson. The mounta was sacred to their ancestors, who believed that it w the home of their gods. But in 1958 Kitt Peak was chos as the site of a new National Observatory, which will be o of the largest and best equipped in the land. After co sultation with the astronomers, the Papagos agreed share the use of their land and Congress passed a speci law to protect the rights of both parties in the agreeme

Modern astronomy requires not only large telescop but much auxiliary equipment, designed and built to high degree of precision. The cost of such installatio places them beyond the reach of individual institution Yet, they are essential to the pursuit of basic research. T National Science Foundation (NSF), established by Co



ess in 1950 for the promotion of scientific endeavor, onsored a number of discussions in 1953 on the possi- ity—and timeliness—of creating a National Observatory. e Kitt Peak project evolved from these discussions.

This is by no means the first venture of the Federal vernment into the field of astronomy. It is true that, ien President John Quincy Adams in 1825 proposed e erection of a National Observatory as a means of hancing American prestige abroad, congressional guf- ws at his "lighthouse of the skies" echoed in all the states the budding Union. But less than twenty years later, the ed for navigational almanacs and instrument-testing ilities had already led the U. S. Navy to the establishment the U. S. Naval Observatory. A few years ago, NSF dertook the construction of the new National Radio tronomy Observatory at Green Bank, West Virginia, to ovide much needed facilities for the observation of space diation at meter and centimeter wave lengths.

ESSENTIALLY, Kitt Peak Observatory will be the optical counterpart of the radio installation at Green Bank. s site was chosen for the steadiness of its atmosphere and e suitability of its climate. Dotting the crest of the moun- in (aerial view, *above*), the principal structures have ready been erected: telescope domes, machine shops, dormitory, dining hall, and office building. Still to be completed are the dome for the largest telescope, the sun tower, and a few auxiliary buildings. Administrative offices and a library are located in Tucson.

The principal telescopes intended for stellar research will be an 80-inch (photo, *left*) and a 36-inch reflector, both of Cassegrain design, the larger instrument being equipped also with coudé focus. Another 36-inch reflector, belonging to the University of Arizona, has been moved to this site as well. The solar telescope has been designed to give a picture of the sun nearly a yard wide. That is to say that its focal length must be about three hundred feet, requiring a building some five hundred feet long to house its mirrors. The structure serves also as the polar axis of the instrument, so that it must be tilted to the horizontal by 32° (the latitude of Kitt Peak). For practical reasons, two-thirds of the building will be underground, so that its supporting tower will rise only a hundred feet above the surface of the sacred mountain.

The Observatory is administered for NSF by a corporation of nine major universities, but its research facilities will be available to qualified astronomers regardless of their academic affiliation. Nor has the visiting tourist been forgotten. A museum is planned, and the kind Papagos have reserved the right to market their handicrafts.

THE SKY IN OCTOBER

From the Almanac:

Full [Harvest] Moon:	October 4,	5:17 P.M. EST
Last Quarter:	October 12,	12:26 P.M. EST
New Moon:	October 20,	7:03 A.M. EST
First Quarter:	October 27,	2:34 A.M. EST

For the visual observer:

Mercury will be in the evening sky all month, reaching its greatest eastern elongation on October 15. But even on that date, it will remain close to the horizon and unfavorable for observation. Mercury will set in twilight forty-five minutes after sunset on October 1; one hour on October 15; thirty minutes on October 31.

Venus (—3.4 magnitude) will be seen after sunset low over the southwestern horizon. It will set one hour after the sun on October 1. one hour and a quarter on October 15, one hour and forty-five minutes on October 31.

Mars, in Gemini, will rise in the northeast at approximately 10:15 P.M., local standard time, on October 1; 9:45 P.M. on October 15; 9:00 P.M. on October 31. It will remain visible for the rest of the night and will be nearly overhead at sunrise.

Jupiter, in Sagittarius, will be west of the meridian after dark, setting in the southwest at 9:45 P.M. on October 1; 9:00 P.M. on October 15; 8:00 P.M. on October 31.

Saturn, also in Sagittarius, will be found approximately 15° east of Jupiter. Low in the southern sky in the early evening, it will set at 11:00 P.M. on October 1; 10:00 P.M. on October 15; 9:00 P.M. on October 31.

The Orionid meteor shower may be expected on October 20. The moon will be new on that date, a fact which should assure favorable observing conditions if the weather is clear. As many as twenty-five Orionids per hour have been observed in some previous years (by a single observer).

Constellation study:

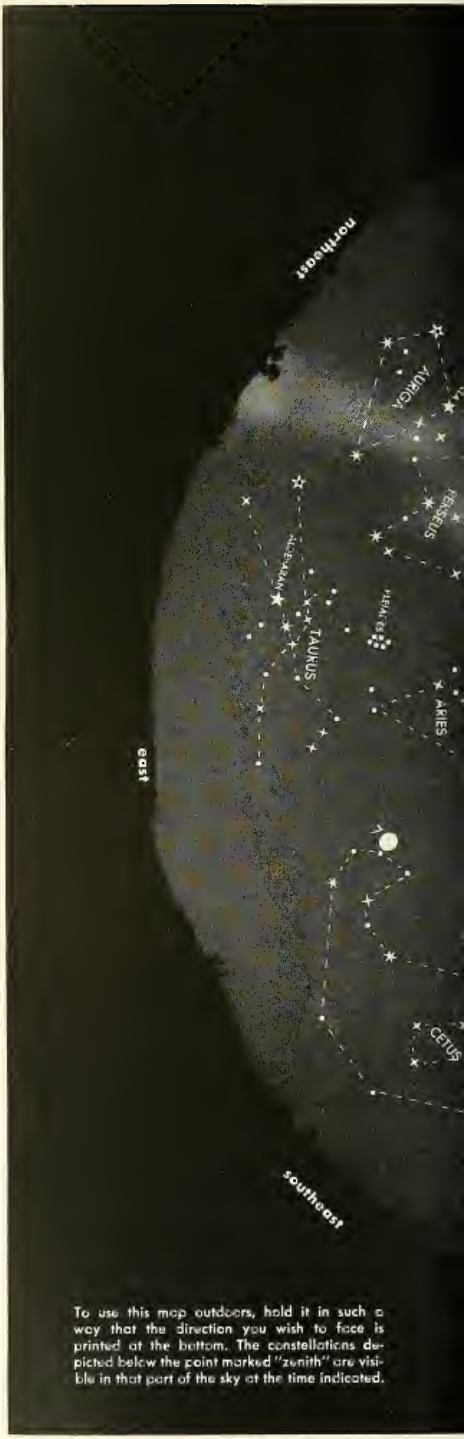
From the standpoint of mythology, the constellations visible over the southern horizon on October evenings are perhaps the wettest in the whole sky. They are all rather faint, but the map, *right*, will help in locating them, and the Great Square of Pegasus may be used as a guidepost.

Pisces (the Fishes) and Aquarius (the Water-bearer) are both in the zodiac southeast and south of Pegasus, respectively. Cetus (the Whale) is low over the southeastern horizon and Piscis Austrinus (the Southern Fish) with its bright star, Fomalhaut, is found just below Aquarius.

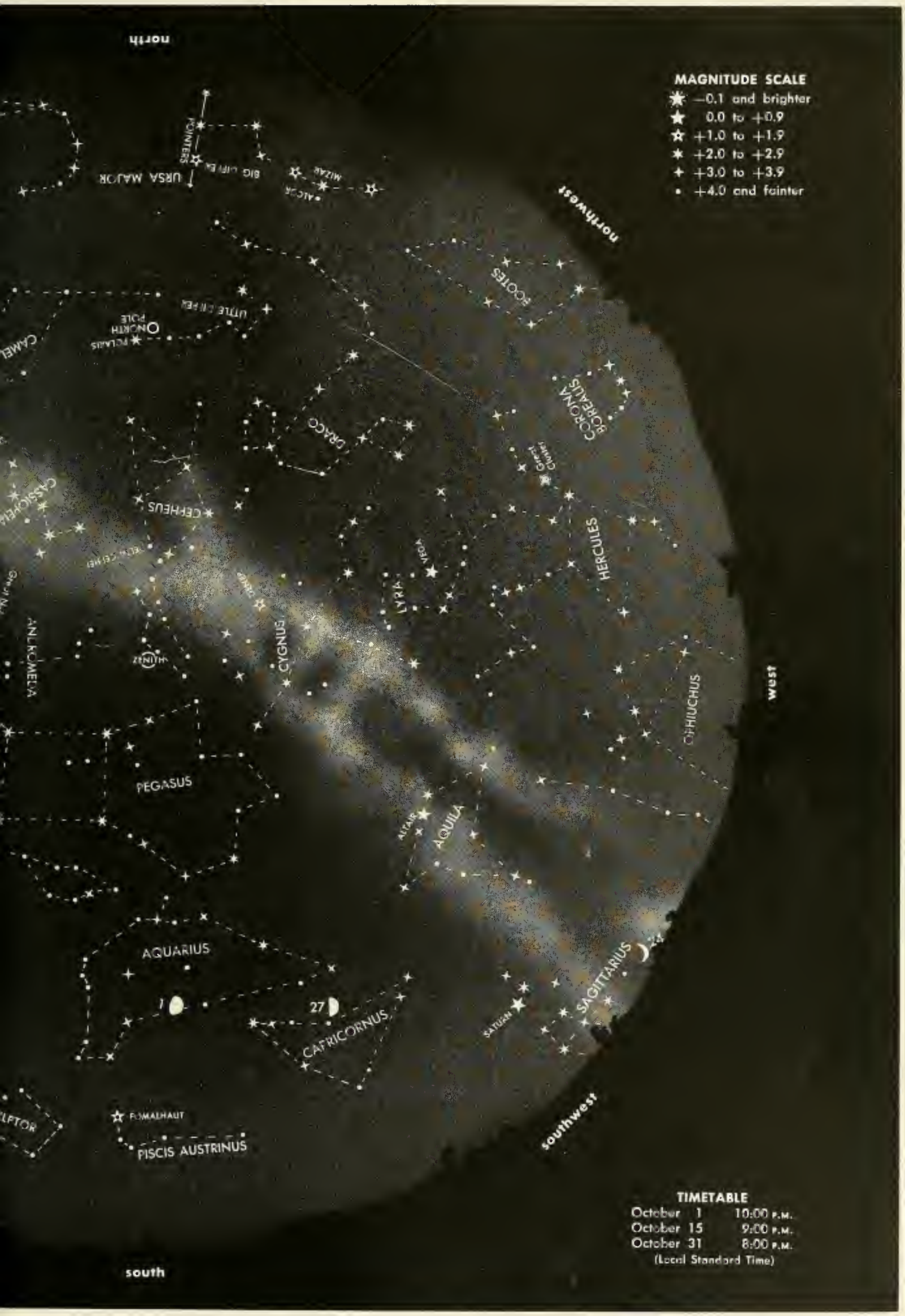
As a matter of fact, the water theme continues below the horizon. Looking southeast of Cetus, an observer at the Equator or in the Southern Hemisphere would see Eridanus (a river of ancient myths) and the good ship Argo, which Jason sailed in his quest of the Golden Fleece.

The identity of Aquarius lies buried in a mass of overlapping myths. The most intriguing one suggests that he may be the legendary king Deucalion. This would commemorate the great Babylonian flood of the third millennium B.C., which is said to have occurred during his reign. The Babylonians believed that their goddess Ishtar had sent the flood; and since the legend of Ishtar closely parallels that of Andromeda, it is probably no coincidence that the latter is found also in this particular part of the sky.

The former Astronomy Editor for NATURE Magazine, MRS. GOSSNER, continues in that role for NATURAL HISTORY.



To use this map outdoors, hold it in such a way that the direction you wish to face is printed at the bottom. The constellations depicted below the point marked "zenith" are visible in that part of the sky at the time indicated.



north
URSA MAJOR
POINTERS
BIG DIPPER
MIZAR
ALCOR
northwest
BOOTES
LITTLE DIPPER
NORTH POLE
POLARIS
CAMEL
DRACO
CORONA BOREALIS
Great Cluster
CEPHEUS
CASSIOPEIA
HERCULES
VEGA
LYRA
CYGNUS
DENEB
ANDROMEDA
ZENITH
OPHIUCHUS
west
PEGASUS
ALTAIR
AQUILA
AQUARIUS
SAGITTARIUS
1
27
CAPRICORNUS
SATURN
southwest
LPTOR
FOMALHAUT
PISCIS AUSTRINUS
south

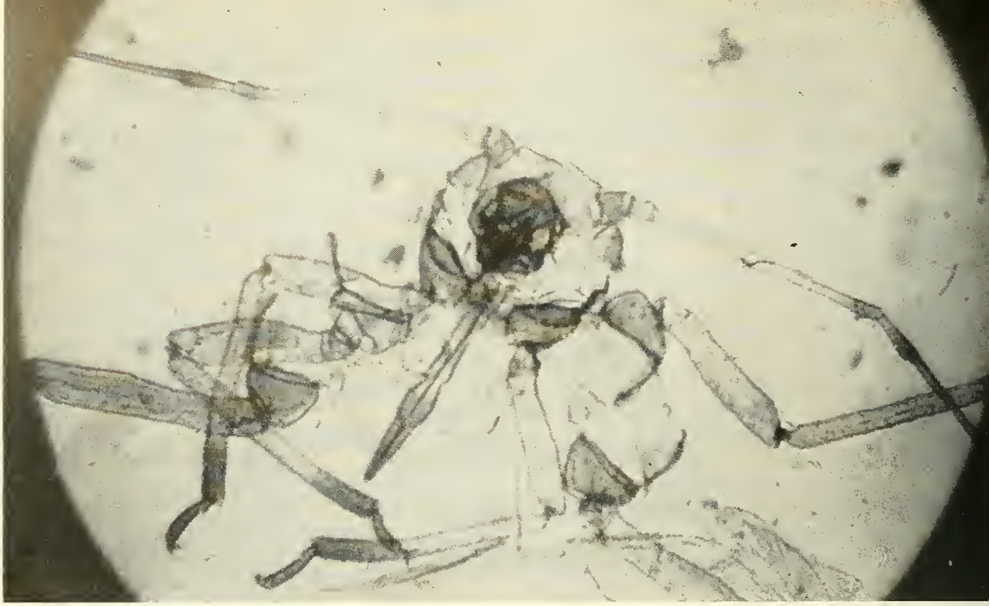
MAGNITUDE SCALE

- −0.1 and brighter
- 0.0 to +0.9
- +1.0 to +1.9
- +2.0 to +2.9
- +3.0 to +3.9
- +4.0 and fainter

TIMETABLE

October 1	10:00 P.M.
October 15	9:00 P.M.
October 31	8:00 P.M.

(Local Standard Time)



UNDER A MICROSCOPE, a prepared slide of an aphid reveals the long proboscis, which sucks juices from plant tissues.

The aphid is not only a serious agricultural pest—it produces winged offspring that carry plant virus disea

YOUNG SCIENTIST

A study of the effect of wave lengths of light on plant li

By RICHARD A. APPLEBAUM

APHIDS, or plant lice, are serious pests in most agricultural countries. Each insect attaches itself to a plant stem or leaf and inserts its proboscis into the plant tissue. It then becomes a living pump, concerning itself with little more than sucking plant juices and producing aphid nymphs. Aphids are economically costly, not only because they directly weaken crop plants, but also because the winged migrants are vectors of plant virus diseases. Hence, experimental work that can lead to an understanding of the factors influencing the number of migrants and the reproduction of aphids, can be very worthwhile.

Aphids normally spend the winter in the egg stage and hatch in the spring. This first spring generation is unique, first because it is wingless and second because it is the founder of the succeeding summer generations, all of which are viviparous (giving birth to living young) and parthenogenetic (reproducing without mating) females. In a few days the progeny gives birth to more viviparous, parthenogenetic females, and so on throughout the summer.

In the fall a generation of males and oviparous (egg-laying) females appears. These mate and produce the eggs that will hatch the following spring.

In my experiment only viviparous (summer) females were raised. There are two forms of these—apterous (wingless) and alate (winged). In the black bean aphid (*Aphis fabae* Scop.), the apterae are also distinguished from the alatae by their darker color and larger size. The apterous female is usually black, and measures 2.5 millimeters by 1.6 millimeters. The alate female has a brownish-black or slightly lighter abdomen. The alate form usually measures 2.4 millimeters by 1.3 millimeters.

In each generation of viviparous females the number of young produced and the percentage of alatae (winged migrants) among the young vary. Several workers have tried to determine the factors that influence the change in reproduction rate and the ratio of apterae to alatae. Overcrowding was found to be one such factor. Reinhard demonstrated (1927) that overcrowding, more than any factor he tested, increased the proportion of alatae in *Aphis gossypii* Glover.

Temperature, humidity, length of day, intensity of light, plant water content, abundance and distribution of host plant
species, diseases (specially fungus
eases), and inherited characteristic
have been shown to affect the repro
tion of aphids and the incidence of
tae among them. Reproduction and
numbers may also be influenced by
and organic chemicals in the soil,
sites such as minute solitary wasps,
dator enemies, and quality or colo
light. Regarding this last factor, t
is, surprisingly, little or nothing in
literature on the effects of colored il
ination on this important insect gro

Methods

IN this experiment, aphids were re
on tall, single-flowering nasturti
The aphid-infested plants were grow
a pot in each of four identical cages,
each cage was covered with a diffe
colored, gelatin-film filter. The c
were ten-inch cubes made of alumi
framework on an aluminum base p
The sides were covered with fine-
plastic screening. The tops were
eighth-inch-thick glass plates that c
be slid open. All cracks were sealed
weather stripping. The filters—red,
low, blue, and gray (the control)—
selected so that each permitted the

RICHARD A. APPLEBAUM became a finalist in the Westinghouse Science Talent Search when he was a senior at Erasmus Hall High School, Brooklyn, New York. He is now a freshman at Columbia College. His paper is the third to be printed by NATURAL HISTORY in a program of reporting the work of young scientists. **DR. T. C. SCHNEIRLA**, whose commentary follows Mr. Applebaum's paper, is Curator in the Department of Animal Behavior at THE AMERICAN MUSEUM.

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mount of radiant energy to pass through, ut in different wave lengths. The filters ere mounted in light cardboard frames.

The four cages were supported on a iding wooden frame (two feet square) et into a large wood cabinet (40.5 iches high by 28 inches by 26 inches). his movable frame supported, in addi-on to the four breeding cages, a dry nd a wet bulb thermometer and a ther-iostat. In addition, the large cabinet ontained (below the cages) an eight-ich fan, a cone-type electrical heating ement and a ventilating flue. Above the iges was a 22-watt cool-white fluores-ent light. The light was switched on for eventeen hours, then off for seven. The in was switched off fifteen minutes very four hours. Both were operated by timing motor-cam-microswitch system.

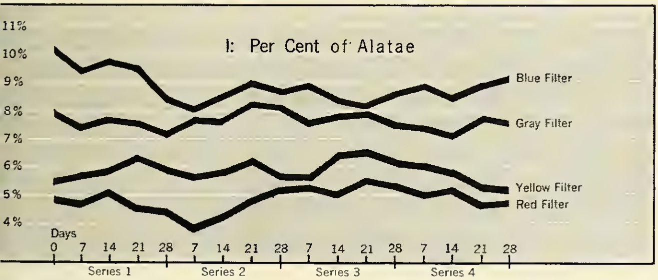
Temperature and relative humidity round the plants were recorded daily. emperature varied from 67.0°F. at night 75.5°F. during summer afternoons. he average temperature was approxi-ately 69.7°F., although the thermostat as preset for 68°F. This variation was ue to the absence of a refrigerating unit, hich would have insured a maximum emperature. The heating unit maintained the minimum temperature at the 67.0°F.

Relative humidity was measured daily and ranged between 60 per cent and 71 per cent, with an average relative humidity of approximately 65.4 per cent. Relative humidity was calculated from the difference in temperature readings between dry and wet bulb thermometers, using psychrometric tables (U.S. Weather Bureau, 1953).

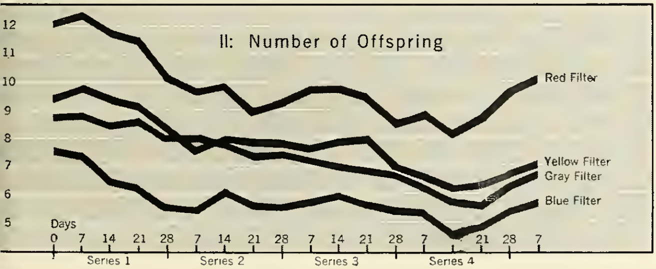
THE planting schedule consisted of: (1) preparing a 2-1-1 soil mixture and filling four 5-inch-diameter plastic pans with the mixture; (2) planting twenty tall single-flowering nasturtium seeds in concentric circles in each pot; and (3) watering, placing the flat containing the four pans in a greenhouse and covering with newsprint.

The plants were raised here for twelve days, then removed from the greenhouse and colonized with black bean aphids. The aphids were reared on nasturtiums for one week, after which they were counted. Meanwhile, a second crop of young nasturtiums was grown, and the aphids were transferred to these.

The first part of the transferring schedule consisted of inspecting the



RAPHS show that with blue, shortest ave length used, the per cent of alate offspring increases, *above*, but number of wingless offspring decreases, *below*.



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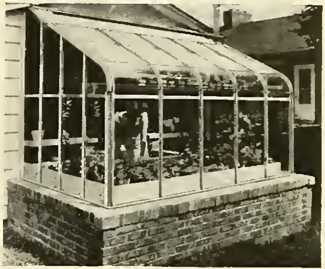

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cages and old plants for alatae; watering the new plants: cutting off the old nasturtium plants at the soil level and counting apterae and nymphs on them. The second part of the schedule started with isolating cut plants having adult apterae clustered at the point where the main stem branches into three smaller ones. This section with the apterae was cut out so it resembled a short, three-pronged fork, then inverted and placed over the same point on the new plant. The living stem was thereby held between the prongs of the old fork. Several more aphid-bearing forks were transferred to the young nasturtiums until a predetermined number of adult apterae had been transferred. Finally, all surplus insects either were discarded, or were fixed for later microscopic examination. The new pot now replaced the old one in the first cage, and the entire process was repeated with the other pots. This is the most straightforward technique I have found for transferring the apterae in *predetermined* numbers without damaging the delicate proboscises, which are normally imbedded in the plant stem.

A uniform number of individuals was removed from the old plants in each "colored" cage and placed on new ones destined for the *same* cage. Thus the transfer made possible a continuous experiment. A "series" was a four-time repetition of the entire schedule. One series extended over a four-week period.

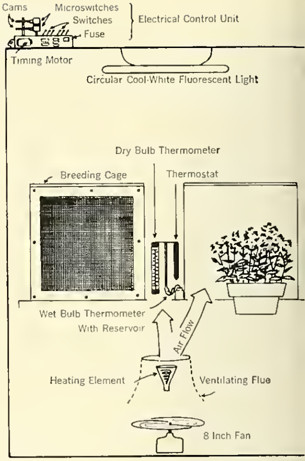
Results

STATISTICS that I accumulated are presented in Graphs I and II. In Graph I, which shows the appearance of alatae, it can be seen that the aphids under the blue filter consistently produced a larger percentage of alatae than those under the gray (the control). Apterae under yellow light produced fewer alatae among their offspring than those under gray filters. Aphids under the red filter, however, produced the smallest proportion of all groups.

In reproduction rate (Graph II), the aphids reared under the red filter far surpassed all others, while the apterae under blue light had the lowest reproduction rate. Gray produced the most stable rate and its line is the smoothest on the graph. Yellow was only slightly higher than the gray, and even fell just below the gray one week, as the graph shows. I noted that whenever fewer apterae were transferred, the reproduction rates in all cages rose (although in different proportions). The reverse occurred when larger numbers of apterae were transferred.

Discussion

IN experiments of this nature it is usually difficult to distinguish *direct* effects of environmental factors on an



MECHANISM for rearing cages includ
controls for temperature and humidit

aphid from the *indirect* influence on t aphid *through* its host plant. Howeve the final effect of the factors is the o that will show up in field studies, and the effect usually measured.

Several environmental factors ha been shown to control the tendency apterae to produce males and oviparo females, instead of parthenogenetic males. Marcovitch (1924) found that short "day" (less than fourteen hour stimulated the production of the sexu aphids. Davidson (1929) demonstrat that low temperatures (less than 66°F tend to increase the number of sexua appearing. These effects were more co vincingly demonstrated by de Fluic (1950). The period of light (sevente hours) and preset temperatures (abo 68°F.) in my experiments were select to prevent the appearance of sexua These would have produced eggs inste of live aphids; thus interfering with t accuracy of data on reproduction ra and appearance of alatae. Througho the experiment no case of apterae p ducing sexual offspring was noted.

A number of workers have investigat the ecology of aphids. Ackerman (192 using the grain aphid, and Smith (193 using mealy plum aphids, found rep duction rates rose with surrounding te perature. Weed (1927) found in *My parsicae* Sulzer, that an increase in r tabolism and reproduction accompan a rise in relative humidity and tempe ture. A. Franklin Shull, who has do much work in this field, found seve factors in addition to overcrowding, re tive humidity and temperature that fluence wing production in aphids. observed more wings in *Macrosiph solanfolii* in continuous light than alternating light and darkness. (Sh

935, 1941, 1942). Lawson (1941) found ie rate of reproduction decreased proortionately as the temperature rose bove 68°F. to 95°F. White (1946) found iat in chrysanthemum aphids the numer of winged forms increased as the ength of the day increased, and deeased as the temperature increased. He ound that starvation induced more latae production than any other factor.

It now appears that color of light is mong the environmental factors influncing aphids. From Graph I it can be een that production of alatae, in per ent of offspring, increases as the light olor of the environment approaches lue. The production of migrants apparently drops under light of longer ave lengths. Reproduction rate (Graph I) rises as the wave lengths of light i the environment become longer.

Summary

SUMMER generations of the black bean aphid, a serious pest, are usually arthenogenetic (reproduce without iating) and viviparous (give birth to ve young). In an experiment with quipment of my own design, I found iat both red and yellow light stimulate eproduction in the wingless viviparous phids, but inhibit the production of inged offspring. Blue light apparently ihibits reproduction while encouraging ie development of winged offspring.

COMMENTARY

APHIDS, both for their evident economic importance and their significance for several types of basic cientific investigation (e.g., of biohemical, metabolic, and ecological henomena involved in aphid associtions with plants and with ants), are icreasingly in use as experimental subects. Mr. Applebaum has chosen an spect of aphid biology that is relatively ew to research. The problem is signifiint, and it is important to note that his eport constitutes a preliminary one, as e plans to continue the research.

Concerning the method, the fact eserves emphasis that aphids are "longay" insects, which, under daily photoeriods of sixteen hours or more (as in immer) continue to reproduce viviparis and parthenogenetic generations but, nder shorter photoperiods (e.g., of velve hours daily, as in the fall) proice an egg-laying generation. This difrential effect of the amount of daylight xplains why a daily photoperiod of eventeen hours was used here.

Although the independent variable ere was the wave length of light, this ivestigation may be classed as one of ie *open* type, carried out under hetrogeneous conditions, because (as xplained) other conditions such as emperature and humidity were also nec-

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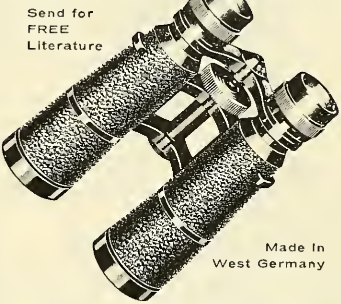

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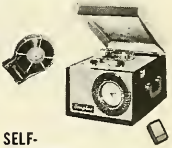

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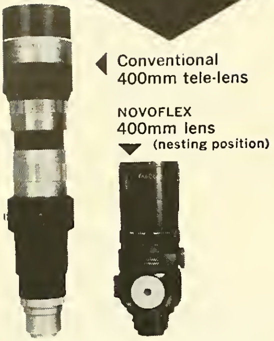
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essarily varying. Daily variations in these dependent variables were not great, however, and it is unlikely that they figured more than incidentally in the results reported.

Because *wave length* was the independent variable, *intensity* of illumination was a major factor for control, and the experimenter carefully selected his four filters so that all of them transmitted light of equal energy. The reader is not informed, however, about a related point. Mr. Applebaum was careful to transfer the same colonies to the respective filters for further tests in the series, but he does not state whether the differently filtered cages were set down each time in the same pattern or were changed according to a *chance* design. Incidentally, the experimenter deserves commendation for his well-devised procedures in the transfer of aphid colonies to new plants and the control of populations.

The results are reported with appropriate caution as indicating that with the shortest of the three wave lengths, production of alate aphids increases and that of wingless, viviparous reproductives falls off, both opposite to the effects of the two longer wave stimuli used. It is a reasonable inference that the differential effect is mainly a visual one. To establish this for aphids, however, visual controls will be needed. For the honeybee and certain other insects, there is evidence for a differential effect of the long and the short spectral waves on behavior and also on metabolism, with the possibility that different receptor mechanisms function in the two cases. On the short wave end, hypersensitivity to ultraviolet radiation is fairly common. That factor is a possible one in aphids but, here, it was probably excluded by the glass cage covers.

Mr. Applebaum realizes clearly that the quantitative and qualitative aspects of reproduction in aphids, as affected by environmental and organic factors, represent a highly complex matter. He has a promising method for investigating these phenomena—one with good potentialities for more sensitive testing of group differences in the comparison of visual and other factors—and he should find interest in continuing this work, in a manner to the advantage of science.

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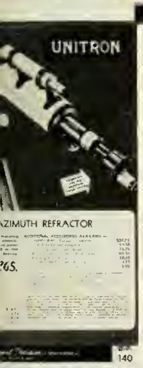

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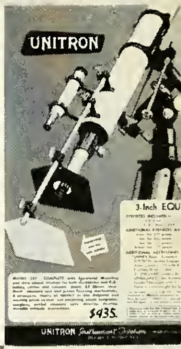

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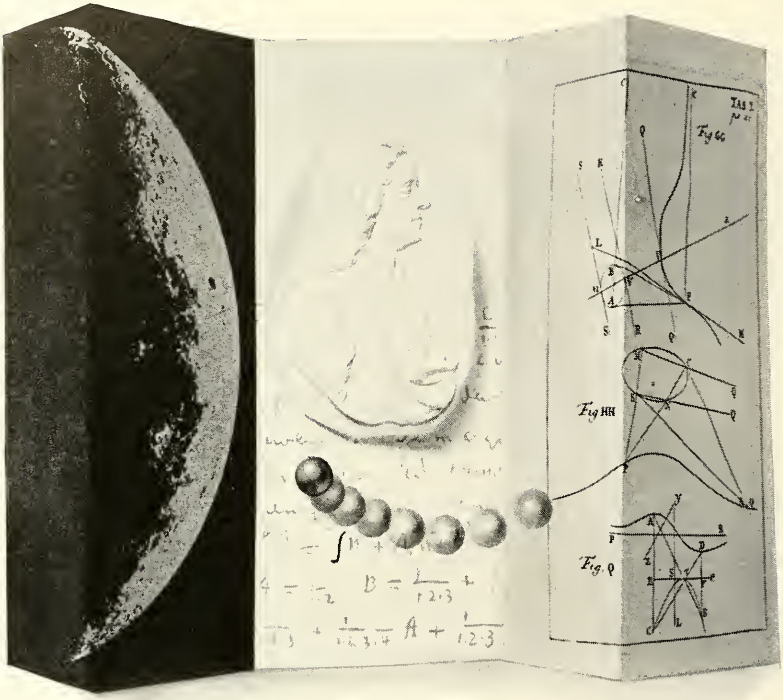

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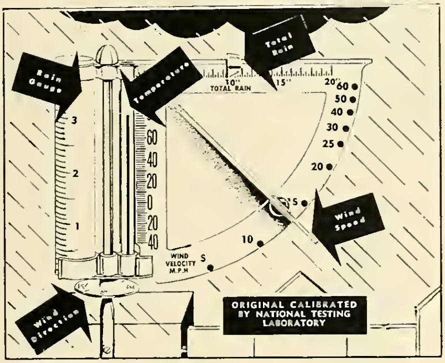

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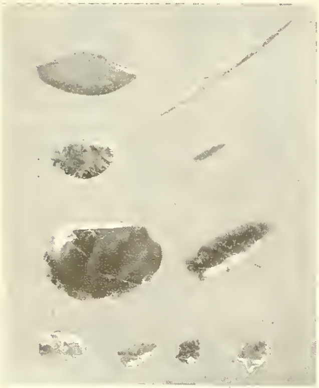

COVER: These artifacts, from the relatively recent slate ulu, or woman's k
and bone arrowhead, *top row*, of the Western Thule culture and proceeding
through Ipiutak, Notched Point House, and Palisades finds, *bottom*, trace hu
life in northwestern Alaska over a span of more than 5,000 years. Aiding gr
in the temporal analysis of the region's cultural leavings is a stratigraphy
derives from the orderly sequence of ocean beach crests. It permits applica
to archeology of beach ridge dating. A search for traces of early Arctic man
uses this approach is described in detail starting on page 10. Photo by Lee Bo

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Reviews

Arabia before the advent of "civilizatio

By CARLETON S. CO

ARABIAN SANDS, by Wilfred Thesiger. *E.P. Dutton, $5.95; 326 pp., illus.*

TODAY the Empty Quarter, as the Arabs who do not live in it call it, or The Sands, as the ones that dwell in it do, is nearly as well known to those who are interested in the world's mineral resources as are the deserts of Nevada and Utah. Self-contained crews of geologists and oil prospectors camp in it, supplied once every few days by airlift from the north. The fabled Rashid and Murra tribesmen, who have long gained a living in The Sands by precarious camel-breeding, now guide workmen for the oil companies, and some are even to be seen in office buildings that have sprung up in Dhahran and Dammam.

Thirty years ago two Englishmen crossed the Empty Quarter, Bertram Thomas from the south and Harry St. John Philby from the north. Because Philby's permits were delayed, Thomas made it first, but Philby's was the harder crossing. Seventeen years passed in which no one tried it again, until, in 1947, Wilfred Thesiger added his name to the list of explorers who struggled over The Sands with camels and Arab companions. He was the last, because after him the age of vehicles and airplanes dropped the curtain on an epoch.

THESIGER not only crossed the Empty Quarter, but he crisscrossed it and traveled along all its borders, exploring as well the virtually unknown interior of Oman. Between 1945 and 1950 he made nine separate journeys. At the end he had so disturbed the various governments controlling the edges of the desert that he could not have gone on with his explorations in Arabia had he wanted to. This limitation gives him a great literary advantage. Not having to worry about future visas, he has been able to tell the truth.

Bertram Thomas was essentially a political officer, who served many years as adviser to the Sultan of Muscat. He traveled by camel from Salala on the Dhaufar coast, in territory belongin the aforesaid sultan, across the middl The Sands to end up in Doha on Qatar Peninsula, another British pro torate, thus avoiding the settled part Saudi Arabia. His adventure won enormous publicity, from which profited in a lecture tour and in the tensive sale of his excellent book, *Ar Felix*. He retired to live in Tangier his grand piano and his golf, and in Cairo shortly after World War I.

Philby, in contrast to both Thesi and Thomas, is essentially a scholar, doubtedly the greatest living autho on the geography of the Arabian insula. After serving in the British a in Mesopotamia in World War I, he came a Moslem and an associate of late King Ibn Saud of Saudi Arabia. still lives in Riyadh. His trip was ta with full permission from his sovere which is why Thomas who traveled w out advance notice, made the cross first. Philby went from al-Hasa across The Sands to the well of Mamu

the southern edge of the desert, and
en looped back, after one false start,
Sulaiyil, in the southwestern corner
the Saudi realm, the land of the
ned Dawasir, some of whose kin now
rk as skilled oil operators and con-
ctors in al-Hasa province.

While Thomas' adventure was a one-
ot tour de force, and Philby's a well-
nned part of a lifelong program of
tematic geographical work, Thesi-
's differed from both in motivation
l in execution. Shunning publicity,
licated to no long-range scheme, and
orived by his predecessors of the
nce of achieving an explorer's "first,"
wanted to map the desert and its
rdering lands, but most of all he
nted to get away from modern life and
ive starkly and austerely with an inti-
te handful of Bedu friends in the
terless wastes that to them were home.

LL my life I had hated machines," he
says (p. 259), and "I would not
self have wished to cross the Empty
arter in a car. Luckily this was im-
sible when I did my journeys, for to
e done the journey on a camel when
uld have done it in a car would have
ned the venture into a stunt." (p. 260).
o bitter was his hatred of automo-
s that one night, on his way into Lai-
rom Sulaiyil, Thesiger saw the lights
a car stuck in the sand. "Resenting
cars, especially in Arabia, I was
her pleased that it was in trouble,"
writes. Later the car arrived at
la, bearing Philby, who had secured

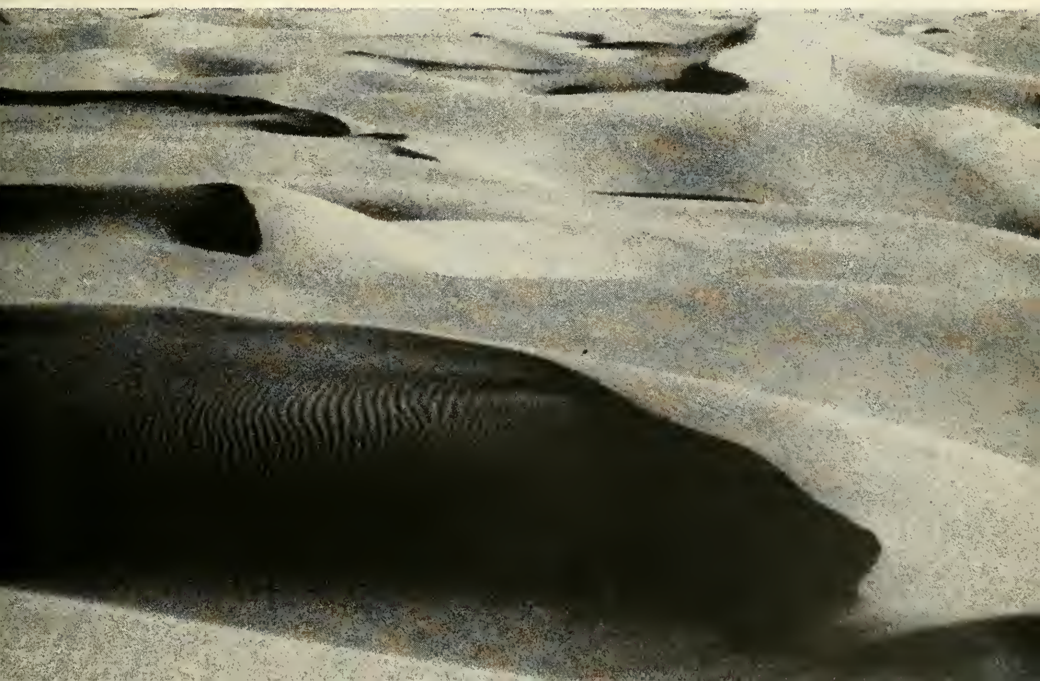
An anthropologist and Arabist, Dr. Coon wrote the classic *Caravan* and other books about the Islamic world.

Thesiger's release from arrest at Sulaiyil and had come to help him.

Both Thomas and Philby, particularly the latter, became masters of Arabic. Thesiger admits candidly that his Arabic is far from perfect and that in some regions he has trouble understanding what is said. Philby long ago became a Moslem, and is respected, if not revered, wherever he goes in the Arab world. Like Thomas, Thesiger made no secret of being a Christian, and had several narrow escapes in consequence. Thomas had a smattering of anthropology and was particularly interested in the Mahri-Socrotan-speaking tribes of Dhaufar. But he measured the lengths of these people's heads incorrectly and made them into a breed of short-headed microcephals, an error which Thesiger, among other writers with less excuse than he, repeated. I have since measured some of these men in Dammam: they are no different from other Arabs in head form. Thesiger has made one original and trivial error; he calls groups of three small stones set together in bunches "trilithons." A trilithon is a large three-stone replica of the Greek letter π. Everything that Philby does is meticulously correct.

It would appear that Thesiger had little if any training in anthropology at Oxford. In a sense this omission was an advantage. Not being burdened with preconceptions born in armchairs, nor fenced in with erudite jargon, he relates exactly what he saw, heard, and felt, and he is an extraordinarily keen observer. The result is a straightforward and detailed account of his life with the men of many tribes bordering the desert on all sides, a much more valuable document than a conventional ethnography. His description of the belated circumcision ceremony in the Tihama of Hejaz is a masterpiece of narrative. In giving the details of blood feuds and camel-raiding and case histories of who kills whom for what reason he has explained the Bedu system of interpersonal relations and code of honor better than anyone since Musil, and in a much more readable manner. In short, Thesiger is not only a keen observer, but he is also a gifted writer. On top of all that, he is a photographer of high professional rank. The illustrations are incomparable.

While heredity should not be downgraded in this or any other case of high achievement, environment must also be invoked to explain the personality and accomplishments of Wilfred Thesiger. He was born in 1910 in Addis Ababa, the son of the British Minister. Brought up among Amharas and Gallas, he saw victorious armies armed with shields, spears and swords march in and out of the capital, and he heard warriors capped in lion manes shout and act



The desolate Sands: traveling east from Jabrin.

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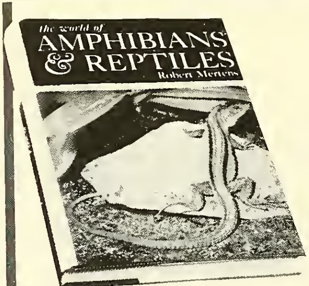

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out their victorious combats before
throne. He was an intimate of
Cheeseman, the roving British co
who chased slavers over the north
Ethiopia and who had, in his youth,
explored Arabia. When he was twe
at Cheeseman's advice, he traveled d
the Awash River into the unexplo
Danakil Desert, inhabited by some of
world's most ferocious tribesmen, to
why that water failed to reach the
He found that it ended in a salt
covered with blood-red algae and
fested with pygmy crocodiles. This
a major feat of exploration, a high-r
ing "first"; a heady thing for a twe
year-old on holiday from Oxford.

In 1935 he joined the Sudanese p
cal service and worked first among
Berber- and Arabic-speaking nomad
the Darfur area, and then among
naked cattle-herding Nuer of the swa
lands to the south. Between times
sandwiched in a trip across the Saha
Tibesti. Then when World War II c
he became a soldier eventually joi
Wingate's force that brought Haile
lassie back to Addis Ababa via the S
and Gojjam. He spent a year in S
mostly in Jabal al-Druz; then he m
on to Egypt and the Western Desert
the R.A.F., and spent the last of the
in Ethiopia as a political adviser.

With this background and ex
ence, crossing the Empty Qu
was a natural goal for a thirty-five-
old who had nothing else to do. At
point, Thesiger, who had done some
logical collecting in Ethiopia, be
interested in locusts. Locusts are a
plague in India, Iran, Arabia, and
Africa. The swarming locust belon
the same species as the solitary g
hopper. Now and then, solitary g
hoppers develop gregarious habits,
bably due to crowding, and change
form so that they look like a diff
species. After a season of good food
ing which they multiply astronomi
a dry season comes along, and they
wing in search of greener fields to
Often borne on the Indian Ocean
soon, they migrate hundreds of
and devour millions of dollars wo
crops. Eventually, disease attacks
and then once more there are only
tary grasshoppers in the world.

For some time there has been an
national Locust Commission, with
quarters in Rome, and a research
in London, headed by Dr. Uvarov. A
is one of the critical areas for locu
they can be spotted there while
ing or on an early leg of their r
tion, they can be destroyed o
ground. In 1943, Ibn Saud permi
locust team to work in his count
those days locust men, like the ve
sects they hunted, had no pa
trouble. They could go almost any

In Oman: peregrine falcons on their blocks.

y wanted in order to save the world's ps. Locusts were a natural medium ough which Thesiger could reach and lore The Sands.

Dne of the suspected breeding areas s Mughshin, on the edge of the desert th of Dhaufar, Thomas' taking-off ce. There, water runs inland from the untains to sink into the sand, and usts apparently breed. In October, 5, Thesiger the locust-killer arrived Mughshin. He not only found no lo- ts, but learned that the country there- uts had been suffering from a twenty- year drought. So he decided to make cond trip westward along the edge of Sands to look for outbreak areas.

N his first trip he took with him four men of the Bait Kathir, a tribe of nads living back of Salala, in rocky ntry. They are a branch of the noble Kathir, as are the Rashid. The Ra- d, however, live in The Sands, on both es, and for Thesiger's purpose the shid were the better men. This posed roblem. The second trip gave him a nce to solve it — he took along two n of each tribe.

Now the center of the desert where omas and Philby crossed is un- upied, although it has a few wells. arly all of the southern edge is also nhabited. On the northern edge, from st to east, live the Dawasir, Murra, l then a somewhat overlapping com- ation of the Rashid, Awamir, Mana- , Manasir, and Bani Yas. On the thern edge are only the Yam in the west, in territory belonging to men, and the Rashid in the far east.

The Rashid not only live on both sides the eastern fourth of The Sands, but y regularly cross it. One man, al-Auf, had even crossed alone. On the way to Mughshin with his Kathiris, Thesiger met a sheikh of the Rashid, who arranged with him to have some of his own men waiting for Thesiger in Salala, after his return from the locust-search along the western wadies. When he was ready for his third trip—and his first crossing of The Sands — he had proper guides to take him. Along with seven Kathiris, four of whom had been with him on his first trip, went six Rashidis, two of whom had been on his second.

On every trip except the first, a Rashidi youth named Salim bin Kabina went along. On six of the other trips Salim bin Ghabaisha was present. To these two young men the book is dedicated. As the narrative moves, we see the character and personality of each of these men unfold, until at the end we feel that we know them as well as Thesiger did. Some of his other companions are depicted with almost equal skill.

All in all, Thesiger took thirty-one men on eight trips. The least he took was four; the most, thirteen. The number of men chosen depended not on the length or rigors of the journey so much as on the need for defense against hostile tribes, for nearly everyone round the edge of The Sands is in blood with nearly everyone else. At the time of Thesiger's travels, the Dahm, a sedentary tribe living in eastern Yemen northeast of Shabwa and northwest of Sana, had been raiding for hundreds of miles along the northern flank of the Hadhramaut and far beyond, in parties of several hundreds, killing men and stealing camels. To them, a Christian explorer loaded down with bags of Maria Theresa dollars and equipped with modern rifles

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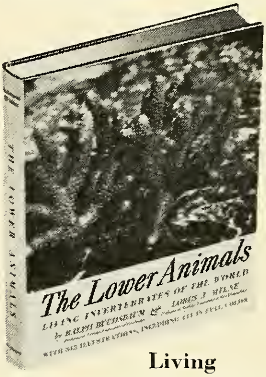
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would have been a fine prize indeed
they and others from the south had b
raiding Saudi territory, Saud had g
the Yam — the next tribe to the n
— an open season on anyone coming
from the south. Over on the western
of The Sands, other rivalries and h
lities created equal difficulties. Mos
Oman itself is ruled by two men:
Sultan, in Muscat, who controls
coast; and the Imam, in Ibri, who r
most of the interior. Still a third, if n
local potentate, Sulaiman bin Ham
controls Jabal al Akhadar, the "Gr
Mountain," which awaits exploration

As a result of all this anarchy and
fusion, Thesiger took with him, be
his hard core of loyal Rashid, men
nine other tribes. They protected
or tried to do so, against their own
ple and allies. The basis of this pro
tion is the old *rabia* system, by whi
member of a given tribe or clan
ducts travelers through his own t
tory, turning him over to the next gu
protector at the border. One susp
that this custom goes back before h
ing to the ancient days of hunting, w
gazelles, oryx, and ostriches abour
on the desert, for it was in use among
primitive Veddas of Ceylon — hun
who resembled the South Arabs ph
cally, but dwelt in caves— while
still controlled much of the island.

To the ancient pattern of tribal fe
Islamic fanaticism added its con
cations. Two kinds of puritans m
trouble for our traveler, the Wal
Akhwan of the Aflaj region, from
laiyil to Dam and Laila. At Sula
Thesiger's companions were put
stocks, and he was kept prisoner. It
then that Philby secured his rele
Nevertheless, as a Christian, Thes
was treated like a leper, spat on,
reviled by children. The other puri
were the members of the Ibadhi sec
Khawarij, living in the interior of Om
It is they who fall under the rule of
fanatical Imam. They, too, found
presence of a Christian intolerable.

On his way up from the Hadhran
to Sulaiyil, Saif al Islam al Hussain,
of the sons of the late Imam Yahya
Yemen, heard of Thesiger's presenc
the desert and sent out two partie
Dahm to kill him. Before they arri
Thesiger shot at a bull oryx and mis
it, much to his chagrin, but he found
later that if he had stopped to ski
and dry the meat, the Dahm would l
caught and killed him.

IN this review, I have tried to give
reader a background of what Thes
is like, insofar as one can tell from
and others of his writings, for of
three crossers of The Sands, he is
only one whom I have not known.
attempt has also been made to desc
the conditions he had to face. If th

e been mostly human rather than ironmental, it is because ninety per t of his difficulties arose from peo- . A Saharan explorer once said to , "Work in the desert would be easy here were no Arabs."

n Thesiger's case, this statement is h intensely true and intensely false. d it not been for the Arabs living und the desert, he would have had hing to face but heat and cold, rock l sand, wind and sun, spiders and rpions, the scarcity of water, and the lity of camels to go without it. Much ld have depended on his own phy- ue, physiology, and mental stamina. ch still did, but had it not been for particular Arabs who risked their s to go with him, he could not have ssed, double-crossed, crisscrossed and veled round The Sands.

he narrative of his first crossing is matic and exciting. The leaking of er skins, the floundering of camels ng led over lofty dunes, the search wells and discovery of bitter water, hunger, exhaustion, and dreams ut food—this is an old but ever-fresh y of man's struggle against the forces nature in the waste places and high ces of the world. We have heard com- able tales of heroic endurance from er deserts, several mountains, and h poles. Had that been all Thesiger to write about, he would be just ther of the explorers.

CKILY for us, it was far from being all. The day-by-day account of what companions did and said tells us e about the life, mentality, and atti- es of the southern Bedu than any- ng else that I have seen in print, or likely to see. These people live in dship with few possessions. Their s are as frugal as lives can be short eath. Death they face every day, and it little heed. They share everything each other; when someone has shot azelle, they draw lots for the meat to id argument, for otherwise each man ld claim he had received too much. y shout instead of speaking, they all at once, and one man's affairs are ry man's business. They follow ctly the Mosaic law of a death for a th. They consider themselves noble- , compared to the Arabs who dwell nd The Sands, and so they are.

fter living among the Rualla, T. E. vrence found it hard to adjust to at home, and Thesiger's uncompro- ing statements about his contempt the Western world suggest a similar culty. Since then, he has traveled in er lands and taken some marvelous ures. If he never writes another book good as *Arabian Sands*, it will not his fault, but that of our present-day ld, which those of us who care about h things are forced to live in.

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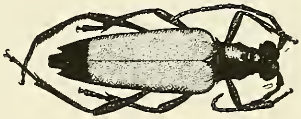
Can you identify this common insect?



It is one of the 1,200 species of beetles identified in

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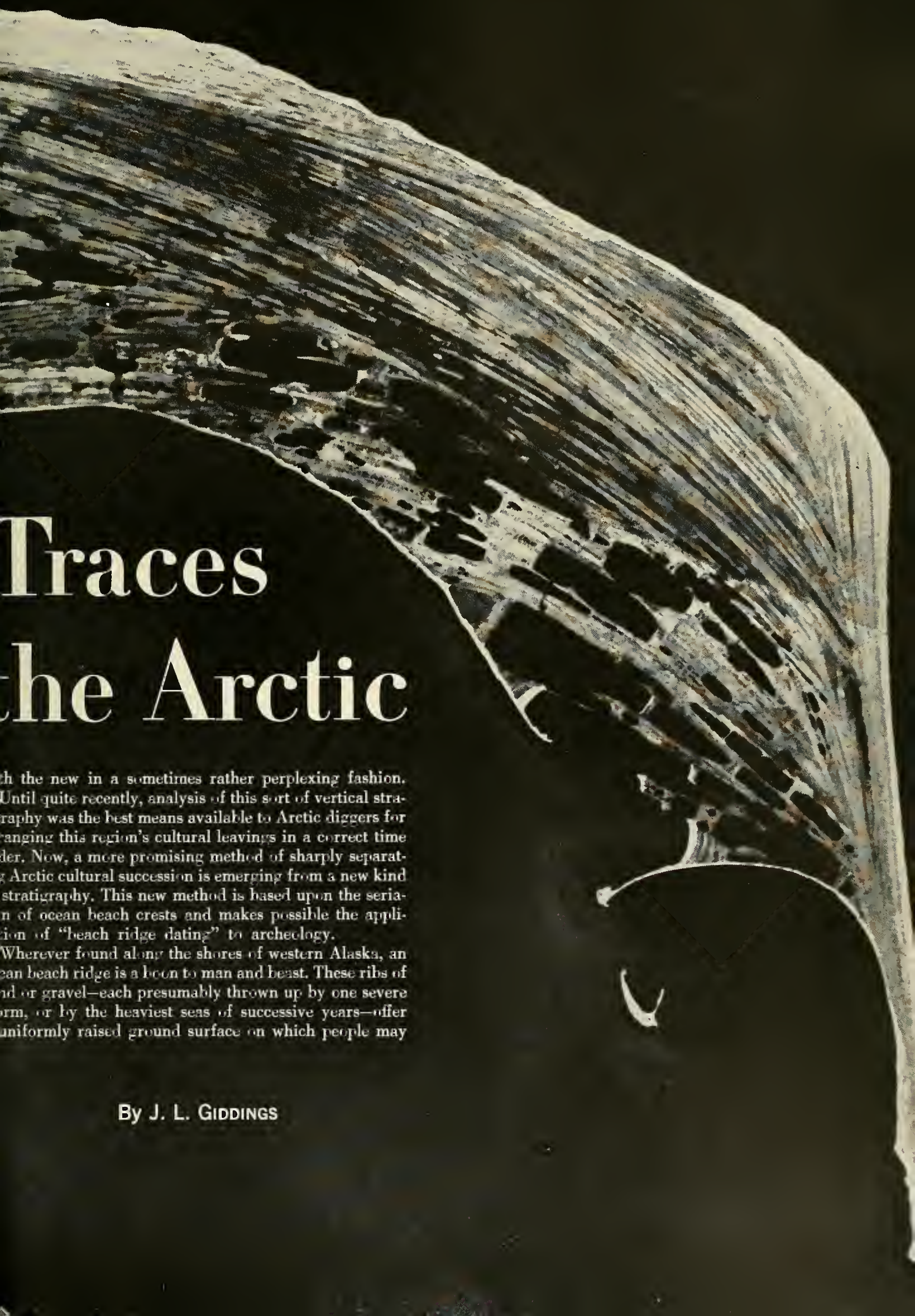
*Leptura emarginata (Sabricius) of the family CERAMBYCIDAE, commonly known as the Longhorn Beetle. Handsomely colored, the longhorns are active fliers or runners, and some are destructive in the immature stages as their larvae bore in the trunks of living trees. They feed primarily on decaying wood.

Firs
# of Man i

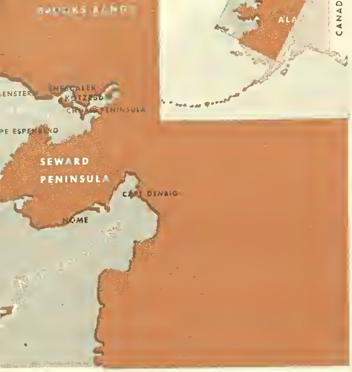
AN ARCTIC ARCHEOLOGIST'S DREAM is a huge, fro
mound of human leavings, so deep that the ent
prehistory of the region may be read like a book from
uppermost to the bottom layers. Some of the mounds t
have been discovered in Alaska, especially those at the t
of peninsulas and on islands, come near to providing su
a record. The Kukulik Mound, on St. Lawrence Island
the northern Bering Sea, for example, contains the depo
of 2,000 years of almost continuous Eskimo occupatio
including houses, rubbish heaps, food caches, and buri
Not even Kukulik may be read like a book, however. Ev
generation of occupants of this mound had dug additio
pits for storage and leveled new, subsurface house flo
and, in doing so, had thrown out the old to be mi



Traces
he Arctic

h the new in a sometimes rather perplexing fashion.
Until quite recently, analysis of this sort of vertical stra-
raphy was the best means available to Arctic diggers for
ranging this region's cultural leavings in a correct time
der. Now, a more promising method of sharply separat-
Arctic cultural succession is emerging from a new kind
stratigraphy. This new method is based upon the seria-
n of ocean beach crests and makes possible the appli-
tion of "beach ridge dating" to archeology.
Wherever found along the shores of western Alaska, an
ean beach ridge is a boon to man and beast. These ribs of
nd or gravel—each presumably thrown up by one severe
rm, or by the heaviest seas of successive years—offer
uniformly raised ground surface on which people may

By J. L. Giddings



Western Alaska sites are shown on enlarged map of area marked on inset.

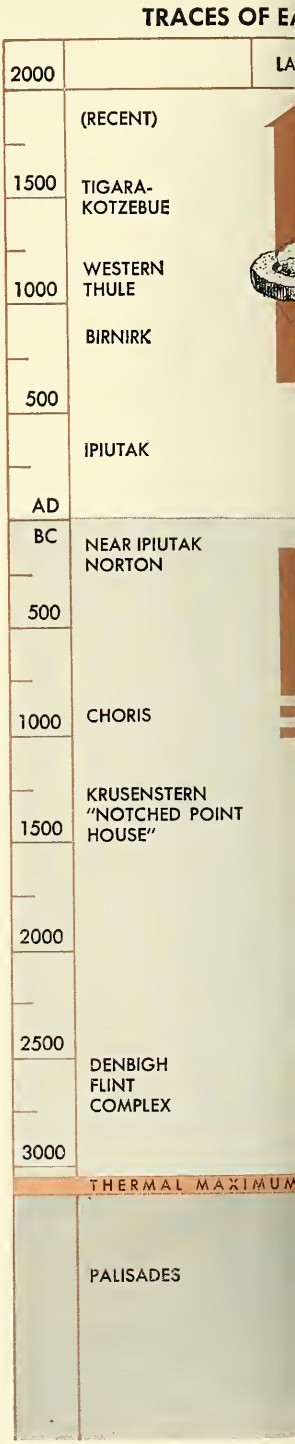
camp or move without resorting to the boggy tundra, to the mud banks, or to the rocky slopes exposed by the beating of waves against the land. Most of the village sites, isolated house pits, and simple camping places of the coastal Eskimos are found on this kind of stable beach ridge.

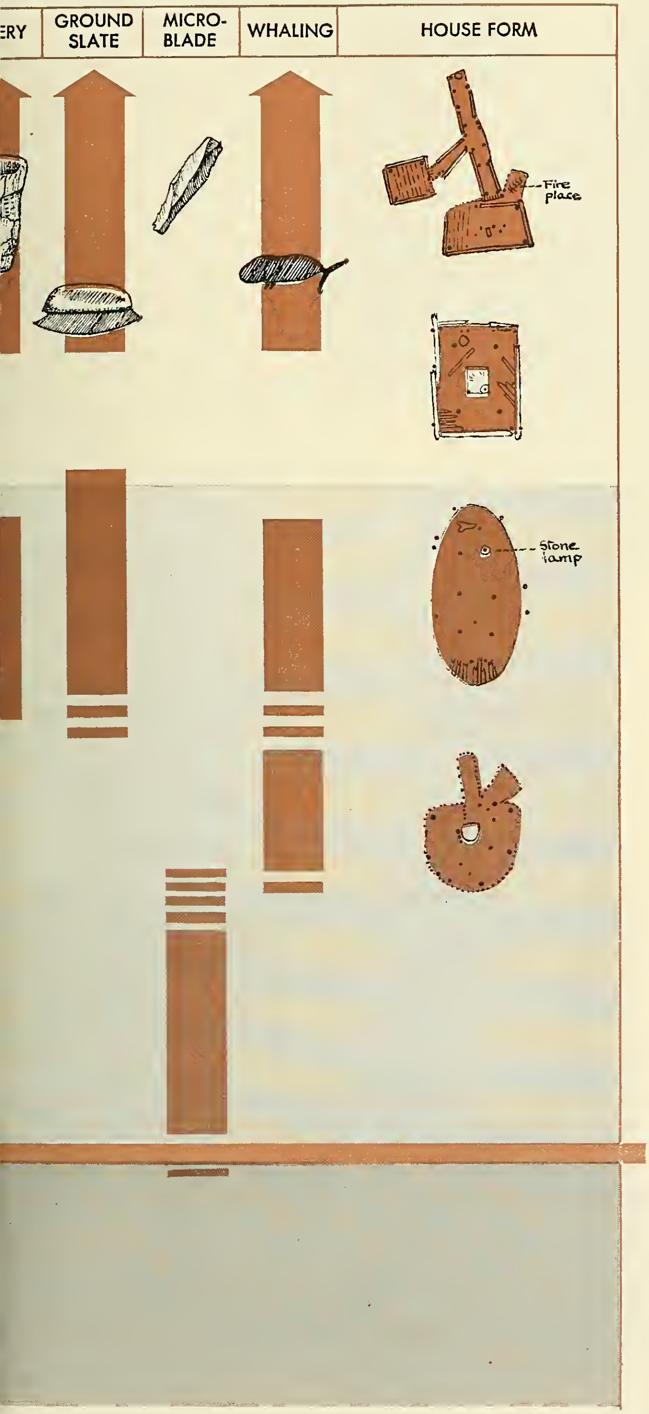
Here the frost leaves the ground early, providing quite dry footing and offering a digging place for the many Eskimo needs that cannot be satisfied in permanently frozen ground. Eskimos invariably choose the high spots on such beaches, from which they have easy access to the sea. The most predictable sources of food lie in the water. Seals and white whales swim near the beach, where they may be secured by an alert hunter; fish are netted close to the shore. The boats used for sea hunts may be protected from wind and waves by hauling them onto the slope. The shore line is, in all seasons, the passageway of friend or foe — traveling by boat in summer or by sledge on the inshore ice during winter. These and other reasons for choosing a beach crest over any other terrain, if one is to remain at the shore rather than beside streams or lakes of the interior, are so compelling as nearly to exclude the use of any other kind of camp site.

Those of us who work at archeology in Alaska have long been accustomed to searching the most favorable parts of such ocean beach ridges. We have also been aware that some of the older archeological sites are located behind the beach crest of today, on an older beach that has somehow been bypassed or sealed off in the processes of shore-building. At Gambell, St. Lawrence Island, both the location of village sites at distances away from the sea, which roughly corresponded to the elapsed time, and the succession of former beach lines, were specifically pointed out by Henry Collins of the Smithsonian Institution as early as 1932. Again, when Froelich Rainey (then of the University of Alaska), Helge Larsen of the Danish National Museum, and I discovered an enormous old site of house pits called Ipiutak at Point Hope, in 1939, we were aware of the existence of the site on beach ridges far removed from the present seashore. Elsewhere, both north and south of Bering Strait, older sites have been identified far enough from the shore to suggest strongly that the sea has locally retreated. The thought that successions of beach ridges might be used as dating criteria was impressed upon the members of our field party, in 1956, at Choris Peninsula.

Choris is a good sea-hunting point at the eastern margin of Kotzebue Sound (*see* map, *left*). There we discovered, on the innermost of nine substantial beach ridges—lying parallel to one another for as much as a mile in length—the pits and floors of three very large oval houses of a form previously unknown in the region (chart, *right*). The building of these houses, we felt, must have taken place approximately 3,000 years ago. This span of time was indicated in part by a comparison of artifacts (photo, pp. 16-17) with those of known sites elsewhere in western Alaska. But it was further confirmed by the presence of varying forms of archeological leavings on and in the beach ridges between the Choris site and the current ocean beach ridge (which is the site of several Eskimo house pits ranging from the contemporary period to at least as old as 500 years).

Growing evidence that some Alaskan beach ridges were built by orderly procedures in nature, rather than by vagaries of wind and ice, led me to propose a specific study of beach ridges for the season of 1958. Supported by grants from the American Philosophical Society and the Arctic Institute of North America, our party from Brown University set out early in the summer to search the shores of Kotzebue Sound for series of beach ridges such as might offer




KANS, THEIR SITES AND TIME PERIODS

a continuous series of archeological sites of considerable time depth.

Place names we encountered were German and Russian ones bestowed by Von Kotzebue (in 1815 and 1816 on his voyage of discovery in these waters) in honor of his sponsors and members of his ship's crew. We traveled by skiff and outboard motor round the 250 miles of the Kotzebue Sound shore line. One important fact emerged from this close search of the seacoast. Those points of land at which successions of beach ridges would be left intact for centuries, despite storms and currents, are relatively few. Where hundreds of miles of beaches may have existed at some period in the past, by far the greater majority will have been swept away. Besides the sequence of old beaches at Choris Peninsula, however, we did find beach ridge sequences containing a range of archeology both at Cape Espenberg, on the south side of Kotzebue Sound, and at Shesualek and Cape Krusenstern on the north side.

Cape Espenberg forms the eastern limit of a sand beach stretching continuously from Bering Strait. The fossil beaches at the Cape lie parallel to the one currently being formed in a succession two miles across. One can walk on a single ridge in an almost straight line for as great a distance as fifteen miles. The present ocean beach is only lightly covered by vegetation because of continuously blowing sand that piles up in dunes of some magnitude. The half-underground houses of recent Eskimo inhabitants are partly exposed where sand has blown away from some of these dunes. In a rather limited search of intermediate beach ridges, we saw some signs of earlier Eskimo archeological remains. We concentrated, however, on a substantial beach ridge more than a mile and a half inland, with a crest width in places of as much as one hundred feet. Potsherds and flints that were recovered from depressions — from which wind had removed sand and in which it had concentrated heavier materials—were characteristic of the old Choris Peninsula culture.

Still farther inland, and separated from the Choris beach by a wide stretch of swamp, lay another substantial beach crest. Materials here, while including an occasional Choris piece, were predominantly those of the oldest archeological horizon

Beach ridges at Choris Peninsula, on eastern margin of Kotzebue Sound, form series parallel to gently curving shore line for length of nearly a mile.

known at that time in western Alaska, the Denbigh Flint complex. Indications are that the Denbigh flints—as we knew them from the stratified typesite at Cape Denbigh in the Bering Sea area—were no less than 4,500 years old. The Cape Espenberg beaches, then, seem to range from an earlier crest—a bit more than 4,500 years old—to a currently forming beach of similar proportions. Cape Espenberg seems to include a promising series of archeological sites.

The archeology of stable, gravel beaches in Alaska, however, is far more inviting than that of the Espenberg dunes of shifting sand. A succession of gravel ridges on the northeast side of Kotzebue Sound proved to be ideal for excavating. Shesualek is the Eskimo name of this spit, which is made up of more than a dozen beach ridges. Here, at least, for one hundred and fifty years of recorded history, Eskimos have gathered in the springtime and remained most of the summer to fish and to hunt beluga as well as to meet visitors in a great trading fair. Today, the village of tents is located—as it was recorded to have been in the 1880's and earlier—on the outermost beach, which faces the water. People may open their tent flaps and see at a glance the condition of their boats, drying racks and nets, or search the water for signs of seals passing by.

We were pleased to find that cache pits and other remains of earlier camps were present on each of the older beaches for as much as a mile behind the present village. A large house pit on the innermost large beach ridge was chosen for excavation. This site was judged from the surface to have the essentially rectangular shape most usual in houses of the western Arctic. An entrance passage was indicated. The house floor and walls lay within a substantial mound of earth that contained, also, an accumulation of bones, artifacts, and other debris of a once long-inhabited underground dwelling.

Styles of many artifacts and the engraving art of this Shesualek house
excavation were new to us, althou
in general the house could be clas
with the Western Thule cult
(which follows the Birnirk culture
that part of the Arctic). The flo
three or four feet below the origi
surface of the ground, was par
covered with split logs or planks.
long entrance tunnel joined the ho
at a considerably lower level th
that of the house floor. To the left
the tunnel entrance, another po
opened into a small, rectangu
kitchen. The floor surface in this a
was thickly covered with ash, ch
coal, bones, and broken pottery, in
cating a long occupancy. Most of
cutting implements, as could be
pected in a house of this period, w
of highly polished slate, althou
flint objects were more promin
here than in the contemporary hou
more to the south. The typical s
ulu, a knife used by women, was
covered in abundance (*see* cover)

A large number of key artifacts
this excavation tells us that
house was built about 1,000 ye
ago. The Shesualek beach ridge
quence was then considerably sma
than it is today. If, as one m
suppose, this beach represents v
nearly the waterfront of its ti
some eleven to thirteen beach rid
have formed during the last mil
nium. By the time of our visit
Shesualek our Eskimo helpers-
particular Almond Downey, wh
boat we used—were acquainted v

Weathered whalebones in the Cape Krusenstern area mark a 500-year-old site. Bones are remnants of upri
that once supported storage platfo

ILDING OF BEACH RIDGES is the result of wave action, hich carries gravel to the beaches from cliffs a hundred miles away. Waves move gravel slowly along shore at slight angle to beach until it accumulates at curve in coast line.

cheology and understood our hopes tying down archeology to specific ach ridges. They told us of a much ore extensive series of beach ridges enty miles farther west. This place called Aniyak in Eskimo and vari- sly described as "portage," "berry- cking place." and "sealing point"— oved to be the expansive series of ach ridges at Cape Krusenstern. We rked there for a few days in 1958, d returned in 1959, accompanied Dr. Hans-Georg Bandi, of the rne Historical Museum, and two own University students, William mmons and Samuel Friedman. In ugust, we were visited at the site by r. Henry Staehle, some of whose otographs are seen on these pages. r work in the summer of 1959 was sisted by a grant from the National ience Foundation.

The sense of discovery that one els continuously at Cape Krusen- ern is not easily described by ordi- ry archeological standards. Most cheologists know, after a few days weeks at a site, the limits to which ey may expect to range. At Cape rusenstern, however, more than a ndred beach ridges lie parallel to e another. although sometimes ob- ured or broken in places by what geologists call "unconformities." It seems probable that all hundred ridges contain remains of human beings.

The extent of the ridges is enormous, as the aerial photograph on pp. 10-11 attests. An observer standing on the crest of the currently forming seashore ridge can turn his back to the sea and walk from one and a half to three miles before he has crossed all the ridges. Or, beginning at one end of a ridge. he can walk its crest for as many as seven or eight miles. We estimate more than three hundred miles of beach ridge at Cape Krusenstern. While the Cape seems never to have been the site of a large village, it gives promise of containing the substance of cultural phases spanning some 5.000 continuous years.

PERIODS of culture about the shores of Kotzebue Sound appear to be indexed, as though by file cards, in the series of beach ridges at Cape Krusenstern. The number of distinct ridges, as we reconstruct them from aerial photographs. is 114. The sites change from those of completely modern Eskimos—on the present ocean front or the next beach behind it—to sites of the Western Thule culture between Beaches 9 and 20.

We excavated a house pit on Beach 10 that proved to be culturally like the one at Shesualek. This buried house had been composite. A large room with a small kitchen at one side lay at the end of a twelve-yard tunnel. while a cross-tunnel from the main passage led to a smaller house floor. By recent Eskimo standards, this would have furnished housing for a large family with two heads of household. Engravings in ivory were somewhat more elaborate than those of the Shesualek house. Not only was there more decoration on the artifacts than we had expected of Western Thule culture but also two pieces of pictographic engraving were found (one is shown on pp. 16-17. *top*), which forced a change in our previous view that this art form was recently introduced into western Alaska.

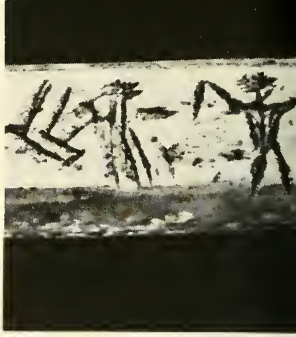
These realistic figures. though few in number, provoke speculation. The figures on a four-sided ivory bodkin. along with typical geometric design elements of the period, are of two men standing on land. a man sitting in a boat. and a caribou. As we interpret the drawing. the men are hurling darts with spear throwers. A dart projects from the shoulder of the deer. The spear thrower is not known to have been used by Eskimos hunting on foot, although it has been widely assumed to have been so used by early American Indians. Rather, among the Eskimos, the spear thrower has been a means of propelling bird darts or sealing harpoons as elements of sea-hunting in kayaks.

The engraving holds still more surprises. Upon closer examination of the boat, one finds that both bow and stern project vertically above the gunwales. This is reminiscent of the large, birchbark canoes made in the Kobuk River region and in the Athapascan Indian country of the Alaskan interior until quite recently. But it is utterly unlike any depiction of an umiak or large skin boat in known Eskimo engravings. Since the present campers at Shesualek and Cape Krusenstern are mainly Noatak River people who come out to the coast only seasonally, it might be supposed that we are seeing in these engravings a bit of the life of river dwellers of a thousand years ago.

A series of wide, shallow depressions, nearly half a mile inland from this house site and located on Beaches 28 to 33, all proved to be house sites of the Ipiutak culture. The five house pits thus far excavated on these beaches seem to represent as many periods of time, yet the artifacts recovered are in nearly all cases identical to those from the Ipiutak site proper. The two largest houses had a form quite unlike that of the others known from Kotzebue Sound excavations and different in some respects from old Point Hope Ipiutak forms. These pits revealed large rectangular floors two or three feet below the original surface, marked by four, evenly spaced posts set in from the corners, and four more posts outlining a central, rectangular fireplace area.

Absence of a passageway indicates roof entry, and the central floor area suggests occupation of the house by many more people than would normally have occupied an Eskimo house in recent times. Unlike the Western Thule and later people, who had hunted whales successfully and incorporated whale bones into their architecture, these Ipiutak builders appear to have done little whaling, although a whaling harpoon head was found in one of the houses. The absence here of polished slate, lamps, and pottery further distinguishes the Ipiutak culture at Cape Krusenstern from both the later and earlier cultures there and show its close relationship to the Ipiutak remains at Point Hope.

On Beaches 39 to 45, behind the Ipiutak series, were found occasional camp sites containing the pottery and other artifacts of Norton and Choris

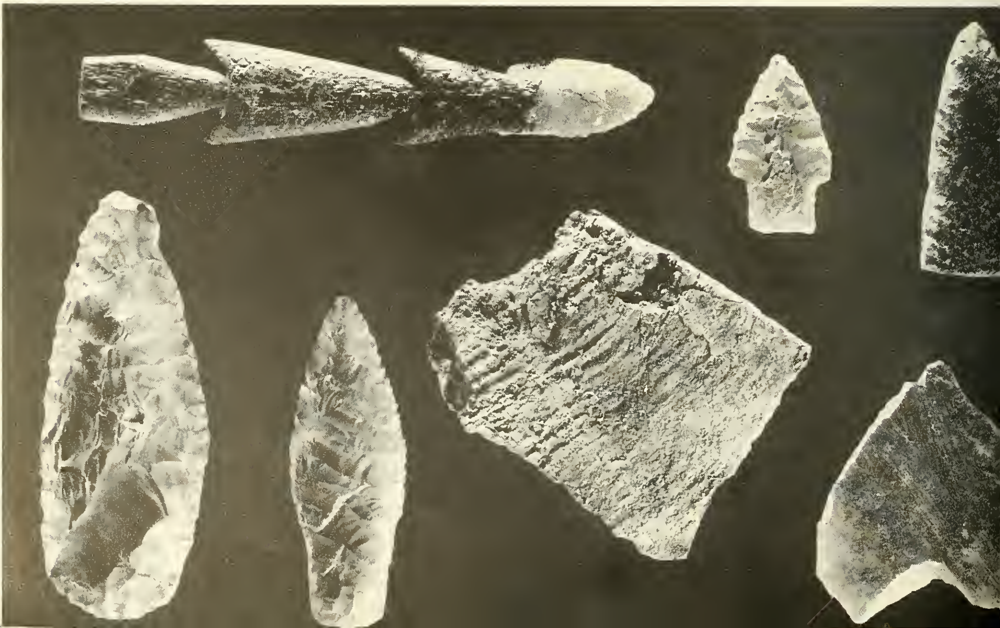


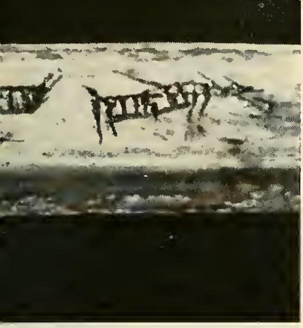
Four-sided bodkin of Western Th
house at Cape Krusenstern is adorn

cultures. This raises again the vi
question of why Ipiutak people
sisted the essentially Neolithic ide
of polished stone, pottery, and lam
when these had been present befo
and were to be used extensiv
again in the same locality.

An unexpected turn of the 1959 se
son came with the discovery
Beach 53 of a house pit (there se
to be two others as well) containi
only chipped flint stone work and
sembling in its particulars none of t
cultures either earlier or later
Kotzebue Sound. The house w
walled by upright, driftwood po
forming a floor outline with a round

Artifacts from Choris Peninsula, *below*, include dart head of bone with a flint tip, a linear stamped potsherd, *center*, and assorted cutting tools and projectile poi
of flint, chert, and slate, probably about 3,000 years o





th pictographic engraving of two men ı land, man in a boat, and a caribou.

ıck in contrast to a cornered front. short entrance passage opened dictly before a large fireplace in the nter of the main room. Another ›orway led to a small room parallelg the passageway. This appears to ıve been a sleeping room, rather an a kitchen, for it lacked ash and bbish deposits that go with a storage cooking area.

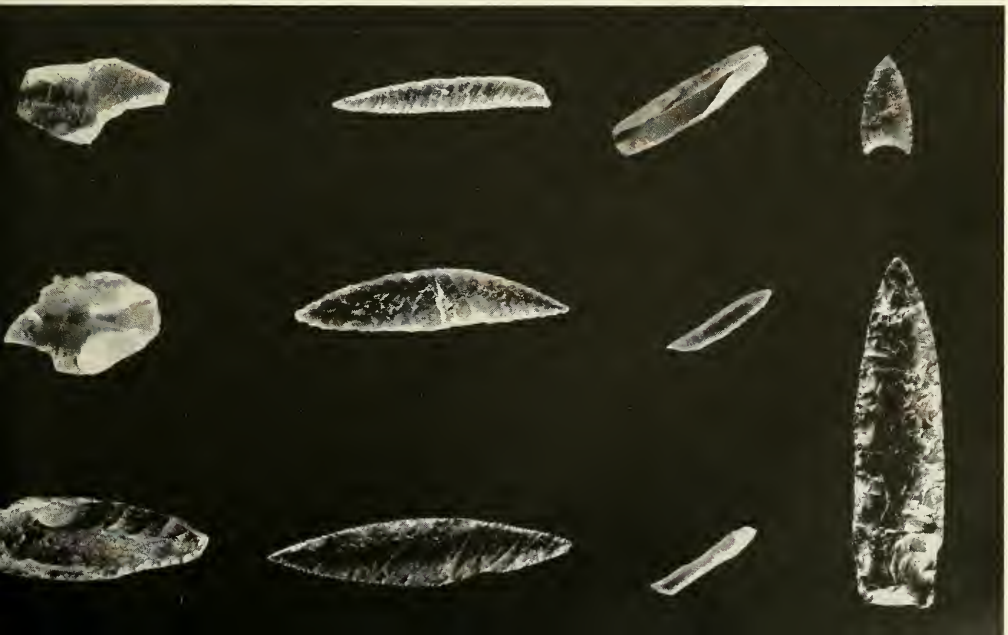
Flint work here was remarkable r the form of the projectile points at probably fitted arrows and ears. These were notched in the les for hafting, after a fashion well ıown in more southerly archeology ıt previously unheard of in this reon. Other flints include notched end scrapers, notched knives, a large, flaked, semilunar knife unlike the polished ulus of Eskimos (*see* cover), and a series of straight-based, broad, bifaced points that closely resemble in size and shape the inset points of whaling harpoon heads. The presence of whale bones — both within the house and in a series of camp sites elsewhere on the beach ridge on which the site was located and others adjacent to it—leads us to think that whaling was practiced successfully and persistently by the people who made these notched points. The sizable number of bones recovered from this house are those of seals, whales, and birds almost exclusively, marking this as a camp of sea hunters rather than hunters of forest game. The presence of whaling, and a culture distinct from all others in the region, on a time level estimated to be between 3,000 and 4,000 years ago, creates a problem for future excavation to solve.

On the beaches landward from—and hence earlier than—the notched point house, we have found to date only a few flints back as far as beaches 101 to 103. These particular beach ridges, however, contain both distinctive small flints of the Denbigh complex and hearths accompanied by these flints. It is difficult to say much about the makers of the Denbigh flints, for the evidence that they have left along the coast—beyond the delicate and remarkable stone artifacts themselves (photo, *below*)—is meager.

No large tools are found in association with the Denbigh complex. Instead, the makers seem to take pride in the incredible reworking of already delicate slivers of chert and obsidian into jewel-like side blades, grooving tools called "burins," burin spall engravers, and a variety of projectile points. If the Denbigh people were whalers, they have left no clear sign of such an occupation in any of the four coastal areas where we have now found these typical tools. However, their association with the same beaches that later supported the sea mammal hunters suggests that they, too, depended in large part on seals and other water game.

Nothing distinct from the artifacts of the Denbigh Flint complex, estimated to be at least 4,500 years old at the time of the last deposits, was being made at Cape Krusenstern when the first beaches began to form there during the thermal maximum, when the ocean reached its highest postglacial level. Evidence of the complex's considerable duration is seen in the presence of microblades, side blades, and other Denbigh-type artifacts, on a 200-foot-high bench across

ELICATE WORKMANSHIP and small size of Denbigh flint eces, *below*, are apparent when compared with the Choris artifacts. All pieces are shown true size. The collection includes both small and large points, gravers, and blades.



the lagoon in back of the beach ridges at Cape Krusenstern. This area would have been desirable as a camp site, it appears, only when the sea lay at the foot of the slope. On this same mountainside, we had yet another surprise in store, for careful search on a higher terrace—approximately 500 feet above the present level of the sea—disclosed a chipping place and the camp site of perhaps a number of distinct peoples down through an undeterminable number of centuries.

ARTIFACTS here include only one or two like those of the beach ridges. All the others are of kinds previously unknown in coastal western Alaska. The most distinctive of these are, again, side-notched points. However, these are stubby, with concave bases: they are relatively crude as compared with the notched points of Beach 53 (*see* cover). Their distinctiveness, together with the fact that they are both patinated and encrusted with lime, sets them sharply apart from other artifacts in the region. Along with these — and indistinguishable as to time of deposit because all are equally at or just below the surface of the eroding bedrock at this point — were two large axlike flints, perhaps designed to be hand-held, and other coarse artifacts and fragments—originally made chert but now exposed long enough have changed chemically into a ba substance. Since the bench was subject to glaciation after the thi or Illinoian, period (ending an e mated 100,000 to 300,000 years ag these coarser objects may well h been deposited on the site durin remote period of time.

DR. GIDDINGS, a professor of Anthropology at Brown University, has done much archeology in the Arctic. DR. STAEHLE, many of whose photos illustrate this article, visited Dr. Giddings' party the summer of 1959.

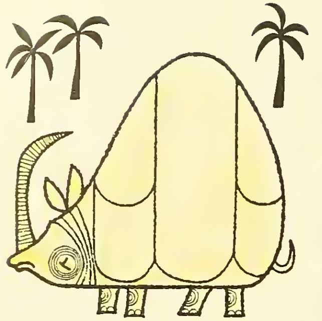
While it is much too soon to whether or not the hearths of the e liest men at Bering Strait will so day be found, we see a clear-cut cheological goal. The orderly be ridges, with their many cultural clusions, and the charcoal from ho fires (to be analyzed in radiocar dating) afford an uncommon opp tunity for exhaustive study of material things made and used

uman beings whose generations seem
 reach continuously back from that
f the present-day Eskimos for at
ast 5,000 or 6,000 years.

THE task of finding well-preserved
records in the ground is greater
; one leaves the beach ridge se-
uences and moves to the hillsides.
urface collections, valuable though
ey are, can never take the place of
uried levels upon which people have
alked and on which they have
ropped belongings. If the more
rmanent camp sites of these early,
ighland" people are ever to be iso-
ted, it will be in the high country
 the interior, for their traces at
rmer ocean shore lines of the Bering
rait region would probably now be
r below the sea's present level.

HIGH TERRACE, *below*, yielded surface finds that predate even Denbigh flints.

FROZEN EARTH over a house site, *top*, was stripped off to expose ground plan.



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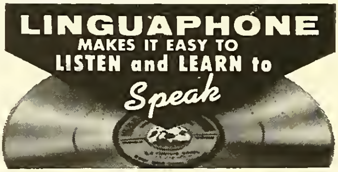

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UTIOUS TURKEYS pick silent way through South Carolina ods. Among shyest of birds, turkeys may run at the snap of a twig. But demand for them as food and disappearance of forest lands have decimated their once numerous ranks.

WILD TURKEY'S RETURN

By Dean Amadon

HE TURKEY is sometimes regarded as the most typical of North Amer-n birds, this despite the fact that very name derives from a mis-en notion that the first ones to ter Europe had been brought from rkey. Indeed, some of the founding hers thought that the turkey, not bald eagle, should be the emblem our young nation. Truth to tell, th have their good and bad points. If, at times, the eagle seems a cowardly scavenger, the male turkey is a rather vainglorious and even ludicrous fowl as he struts about, tail fanned, gobbling out his challenge.

Be that as it may, the wild turkey is one of the shyest of all birds and there are few who ever see him in the throes of courtship. Rather, it is the fortunate woodsman, walking quietly through the autumn forests, who may be rewarded with a glimpse of the bronze, streamlined turkey as it picks its way among the wild grape and scarlet ivy in some long-abandoned orchard. A twig cracks and the bird is gone, running silently and swiftly down the aisles of the forest.

The pilgrims found wild turkey in the New England woods and, from this northeastern outpost, the birds ranged south to Florida, west to the

Powerful wingbeats and ample wings make turkey a strong flier in spite of its weight. Duration of its flight is short, usually a matter of minutes only.

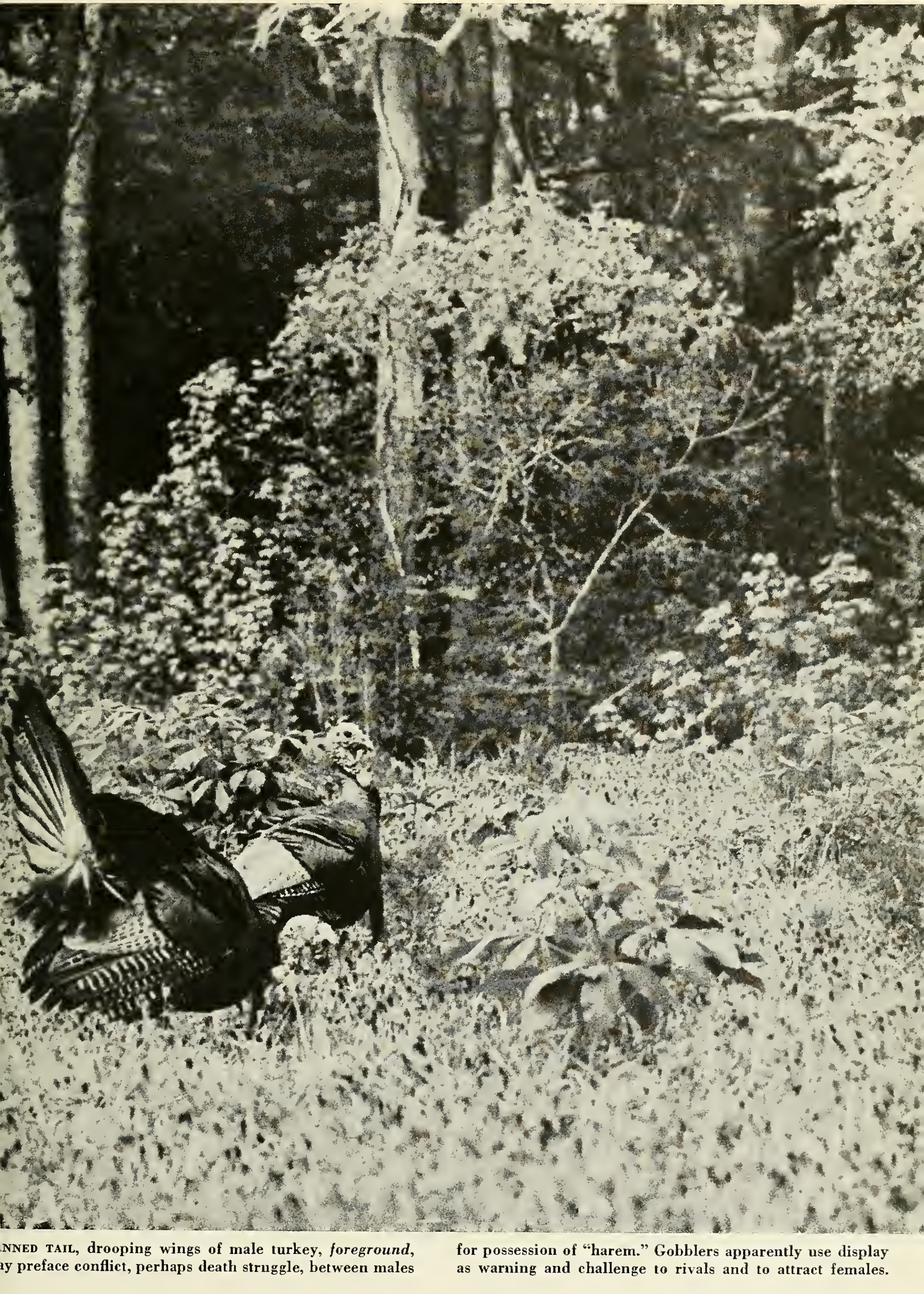
Mississippi bottoms and, in suitable areas, west to Arizona, and south over the plateau of Mexico. From much of this range they have long since disappeared. Massachusetts has its Mount Tom but the old gobbler after which it was named, the last of his tribe in that state, went to his reward about the middle of the last century.

Some wildlife disappears because its habitat is destroyed, some because it is hunted for food or for sport. Unhappy the creature whose ranks are depleted by all these factors. But such is the turkey. Calling forth all the skill of the sportsman, it is, once secured, a culinary prize without a rival, unless this be the Chesapeake Bay canvasback. Small cause for surprise that the range of the turkey has shrunk alarmingly. Furthermore, in the wilderness to which it retreats, game laws are not always strictly observed. The Okies, the crackers of the Florida or Georgia glades, the hillbillies of "Yoknapatawpha County," find it easier to shoot a turkey off its roost as it crouches silhouetted against the moon, or to pot the gobbling males in the spring, than to follow them in fair hunt during the fall or winter.

The disappearance of the chestnut tree struck a blow at the sustenance of the turkey. The cutting of forests of white oak and other mast trees also contributed to the problem faced by such a non-migratory bird of this size in surviving the winter. In the South, deterioration of the game range as a result of overgrazing, burning and clearing has been equally disastrous. Nevertheless, *Meleagris gallopavo*, as Linnaeus called our bird, finds its present stronghold in the brakes and swamps of our southern states. It is in such scenes, in South Carolina, that the sportsman and amateur ornithologist, Dr. Carnes Weeks, secured the remarkable photographs that illustrate the article on these pages.

Here the hen turkey hides her nest in the depths of a palmetto thicket. At daybreak she stealthily enters it to lay a large egg, which, unlike that of the pheasant or chicken, is flecked with reddish spots. This is repeated each morning until the full clutch of eight to fifteen eggs has been laid. Then begins the hazardous twenty-eight days of incubation. If, by the end of that period, the eggs have not been detected by wandering possum or coon, the young turkeys emerge from the eggs and follow their mother.

Audubon, who was able to observe the wild turkey in the days of its abundance, penned the following eloquent description of this scene:



NNED TAIL, drooping wings of male turkey, *foreground*, ay preface conflict, perhaps death struggle, between males for possession of "harem." Gobblers apparently use display as warning and challenge to rivals and to attract females.

"Before leaving the nest with her young brood the mother shakes herself in a violent manner, picks and adjusts the feathers about her belly, and assumes quite a different aspect. She alternately inclines her eyes obliquely upwards and sideways, stretching out her neck, to discover hawks or other enemies, spreads her wings a little as she walks, and softly clucks to keep her innocent offspring close to her. They move slowly along and, as the hatching generally takes place in the afternoon, they frequently return to the nest to spend the first night there. After this they remove to some distance, keeping on the highest undulated grounds, the mother dreading rainy weather, which is extremely dangerous to the young in this tender state, when they are only covered by a kind of soft hairy down of surprising delicacy. . . .

"In about a fortnight the young birds, which had previously rested on the ground, leave it and fly at night to some very large low branch, where they place themselves under the deeply curved wings of their kind and careful parent, dividing themselves for that purpose into two nearly equal parties. After this they leave the woods during the day and approach the natural glades or prairies in search of strawberries and subsequently of dewberries, blackberries, and grasshoppers, thus obtaining abundant food and enjoying the beneficial influence of the sun's rays."

Known for his popular and scientific writing, Dr. Amadon is Chairman of the Department of Ornithology at The American Museum. Dr. Carnes Weeks, a notable amateur of birds, made the accompanying photographs.

In the northern states large tracts of farmed-out hills have reverted to woodlands, or have been reforested. The turkey, because of its feeding requirements, has benefited less from this trend than have, for example, the deer, the porcupine, or the pileated woodpecker. Notwithstanding, there are now enough oaks, beech, and shagbark hickories in some of this second growth to support turkeys and they are beginning to spread, for example, from *Penn's Woods, West* into the southwestern tier of New York State: Allegany and Cattaraugus Counties. Interestingly enough, it was
this area—near the little town
Ceres—that the passenger pigeo
which also subsisted on oak a
beech mast, made its last extensi
nesting in New York.

Game technicians and estate ow
ers have sought to accelerate th
spread of the turkey by re-stockin
The problem is to obtain really wi
birds. As with the mallard duck, t
red jungle fowl, and other species a
cestral to the domestic animals of o
barnyards, it is difficult to keep t
wild stock of turkeys from becomi
diluted by domestic strains. Profess
A. Starker Leopold of the Universi
of California has studied the practic
and theoretical aspects of this pro
lem and published a learned stu
entitled "The Nature of Herita
Wildness in Turkeys." One means
preserving this wildness is to ke
wild hens in high wire enclosures th
only truly wild gobblers can scale
rather, fly into. Only by such caref
attention can those attributes ce
brated by American naturalists sin
the time of Wilson and Audubon
perpetuated in the flocks of wi
turkeys that come from game farm

Undisturbed by crow, a gobbler feeds unconcernedly while a more wary companion keeps watch. Hens hide nests from crows, but latter will often follow them to nests a wait until hens have left again, then steal and eat eg

RONZE FEATHERS GLEAM as turkeys take sun in a clearing edge of the woods. Reforestation in northern states and re-stocking may help wild turkey spread north. Problem remains of keeping wild birds free from domestic strains.

1

TARPON
ATLANTIC SAILFISH

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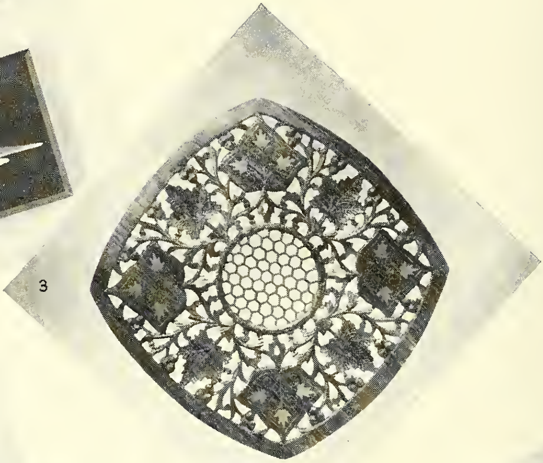

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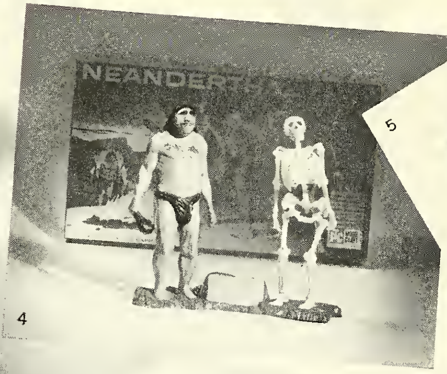

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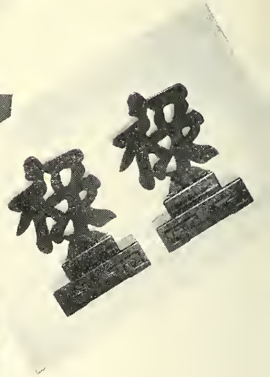

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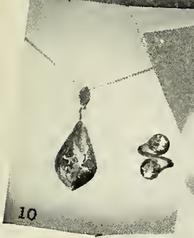

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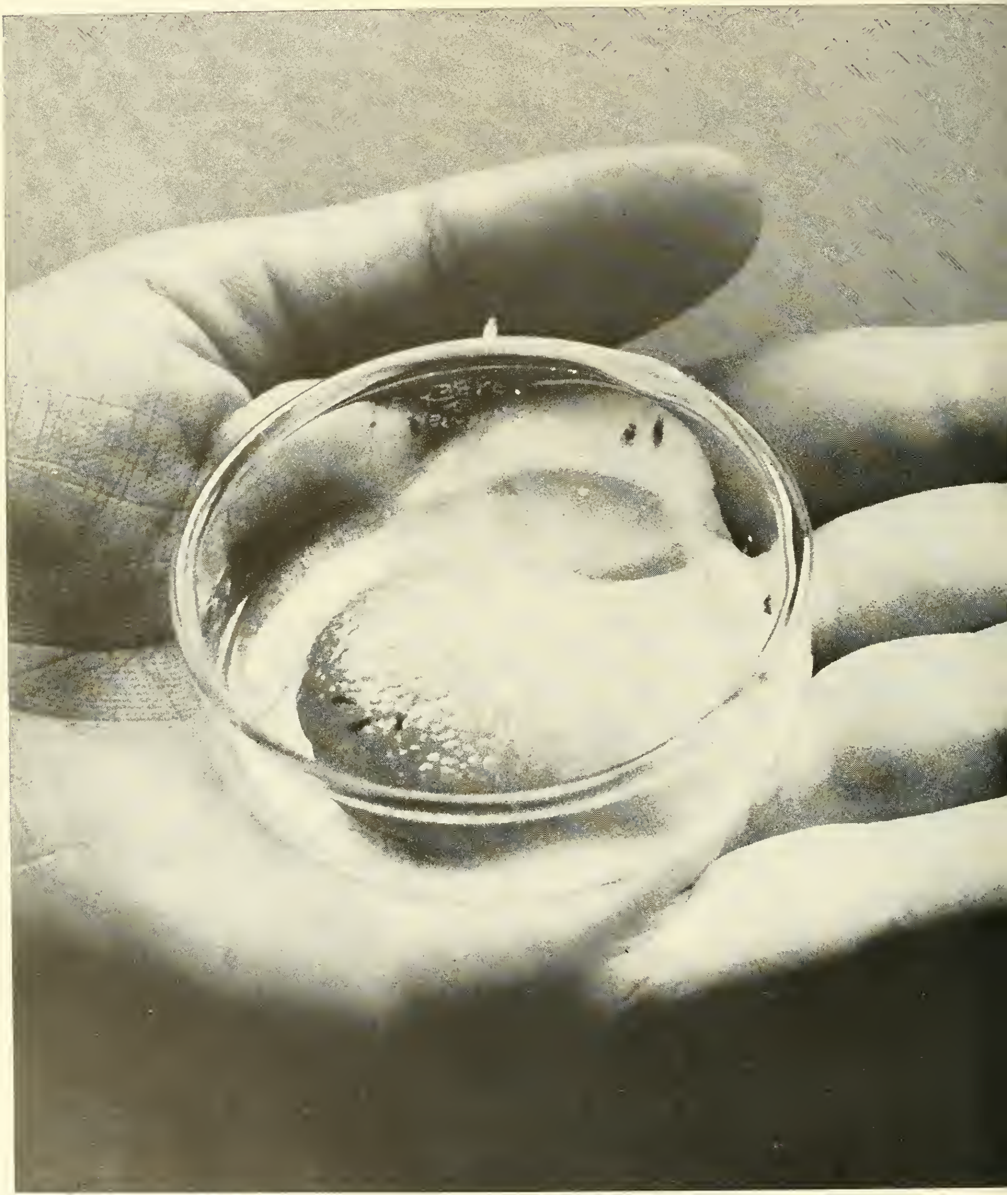
FLIES MATING: A PICTORIAL

A species of fruit fly, Drosophila paulistorum, occasions som

By Lee Ehrman and Monroe W. Strickberger



Petri dish in which experiments were conducted is held in Dr. Ehrman's hand: dense matter on bottom is cereal used as food by fruit flies. Dr. Dorothea Bennett and Mr. Char Morlang both helped the authors in taking the photograp

RECORD

xceptional photos

THE GENUS DROSOPHILA, the fruit
fly, has long been considered ideal
or the study of genetics in the labora-
ory, largely because of the awesome
eproductive capacities of these tiny
reatures and the ease with which they
ay be raised in cultures. Then, too,
e number of species within the genus
s large, so frequently hybrids are
eadily obtainable. In our work at Co-
mbia University, we were led to
udy one species, *Drosophila paulis-*
orum, in order to analyze the be-
avior of its subgenus, *Sophophora*,
ne of the seven that comprise the
rosophila family.

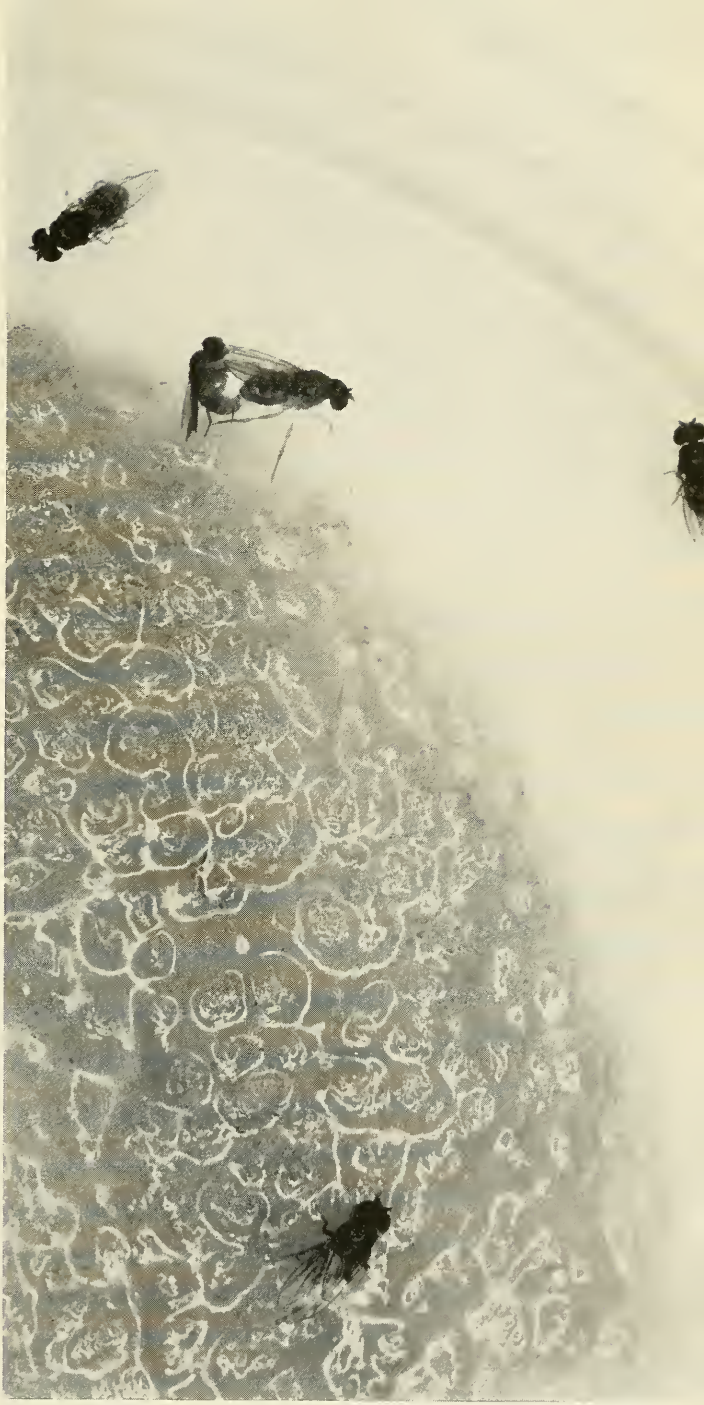
For the purpose of our study, newly
atched flies were separated by sex,
nd aged from four days to one week.
hey were then placed, without etheri-
tion, into glass observation cham-
ers, with a small amount of food.
lies of the opposite sex were then
troduced. The flies photographed
ere all belong to the Amazonian sub-
ecies from localities in northern
razil, this geographic group being
lected for the rapidity with which
pulation occurs after introduction.

Sexual recognition is a trial and
ror affair among drosophilids. Males
ill court females of any species, and
ill immediately repeat courting and
ating. Courtship itself consists of
ur distinct elements.

In the first stage, that of *circling*, the
ale approaches the female, attracts
er attention, and, at the same time,
mits her movements by running
round her. He never completes the
rcle, but turns round, reversing his
rection about every 330°.

Next he begins a *tapping* action—an
portant aspect of courtship in this
ecies. The male lightly touches the
gs and the abdomen of the female.
t first, only one leg of each fly is in-
lved. Since many taps are neces-

DR. EHRMAN is a Fellow in zoology at Columbia University. The present investigation was conducted under a postdoctoral grant awarded her by the Division of General Medical Sciences, U.S. Public Health Service. Most of the remarkable photos were taken by **MR. STRICKBERGER**, also of Columbia.



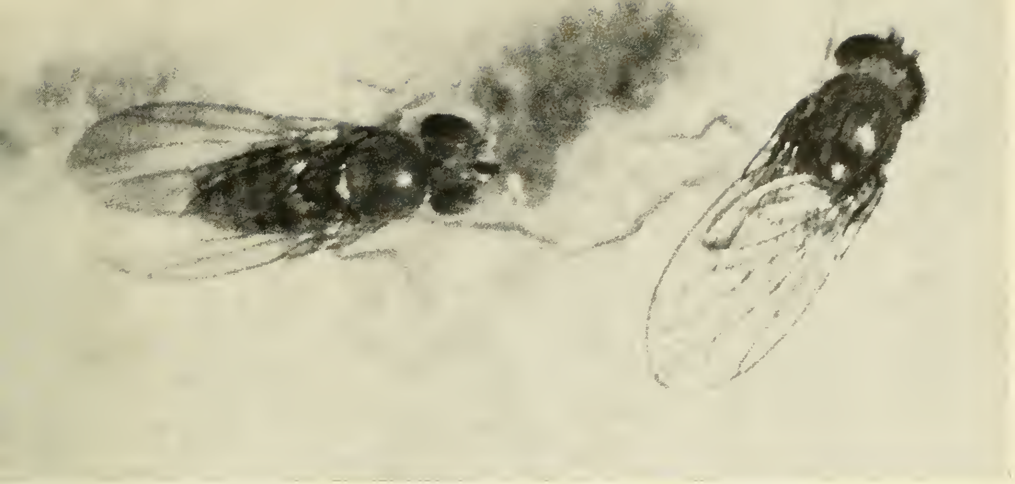
DETAIL of dish includes couple that was photographed as the mount approached its conclusion and the female, with her hind legs, was pushing the male away.

APPROACH BEGINS as male, on left, draws near a female and begins circling motion. In *Drosophila paulistorum,* there is no difference between the two sexes as regards pattern bands on abdomen, but the male is smaller than the femal

sary before it is established that the male has located a female of the same species, the male continues to circle between contacts. Here, the question of the female's receptivity is settled.

Licking and *wing vibrating* occur next, both as a prelude to mounting. As one authority, H. T. Spieth, has descibed it, the male "goes to the rear of the female and assumes a slightly crouched position with the tip of his abdomen slightly curled. Having positioned himself, he extends one wing 70° to 90° and vibrates it periodically, twisting his body on the longitudinal axis as he vibrates, taps (uppercuts), and occasionally licks or attempts to lick the female." In licking, the male proboscis contacts the female genital —and this is a reliable sign that t male is about to rush in for the mou In *D. paulistorum,* wing vibrations a not so important a part of courtship in some of the other species. The o wing that is vibrated is used for leve age as the male raises himself on t body of the female.

CONTACT BECOMES CLOSER as male, *left,* touches female with other legs. Female appears to be very receptive, since she allows the male to approach, and male is no longer force to circle her, as in picture above, to prevent her escap

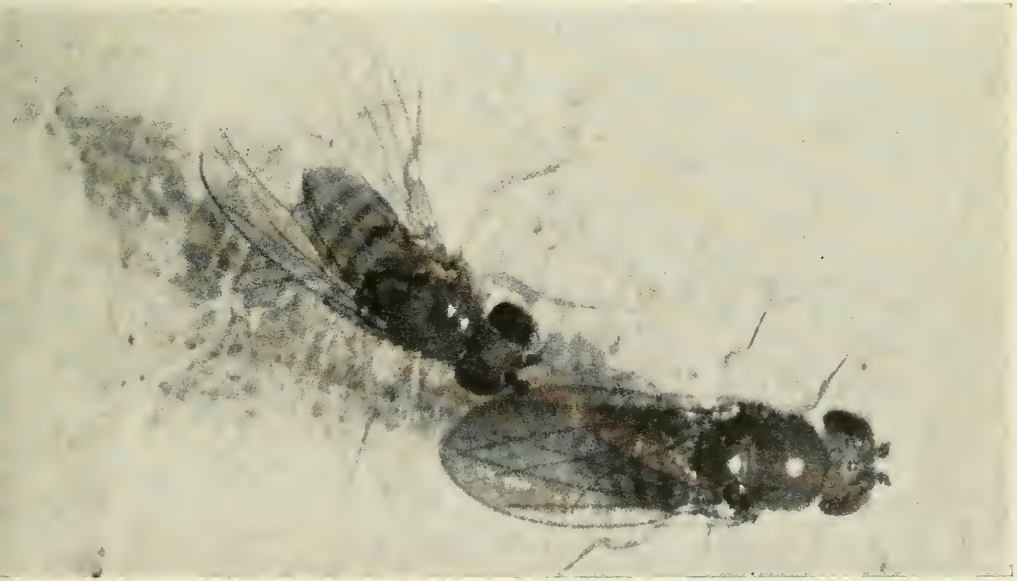


IRST "TAP" is given as male, *left*, touches the female with)releg. By this action, the male establishes the fact that he has located a female and, in addition, one of the same species. Contact also offers female her first chance to reject male.

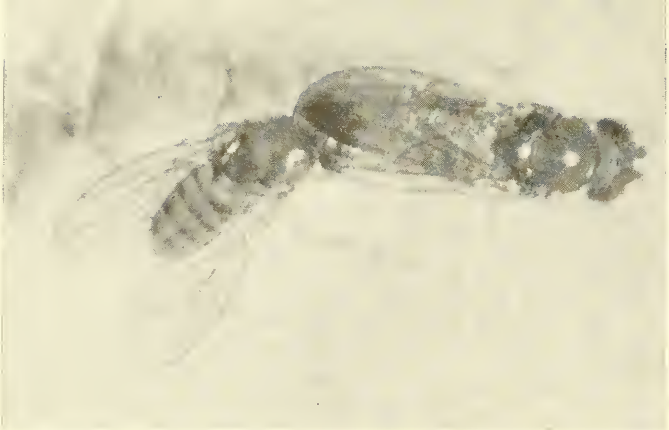
Mounting and *insertion* seem to be ccomplished simultaneously. A por- on of the male reproductive organ is sed in a clasping manner and, after iounting, the male secures his posi- on on the female by placing his fore- :gs on top of her slightly spread 'ings. This additional support is im- erative because copulation lasts a fairly long time in this species (an average of 17 minutes and 12 seconds). During the copulatory period, the female may turn about or walk round; and she may even find herself having to fend off other males.

When copulation is nearly over, the female attempts to dislodge the male by vigorously kicking and swinging her body from side to side. The male loses his hold on her wings when she snaps them together, and seconds later he falls off backwards. Thereafter, the female repels all sexually excited males by raising the tip of her abdomen, making her genitalia inaccessible.

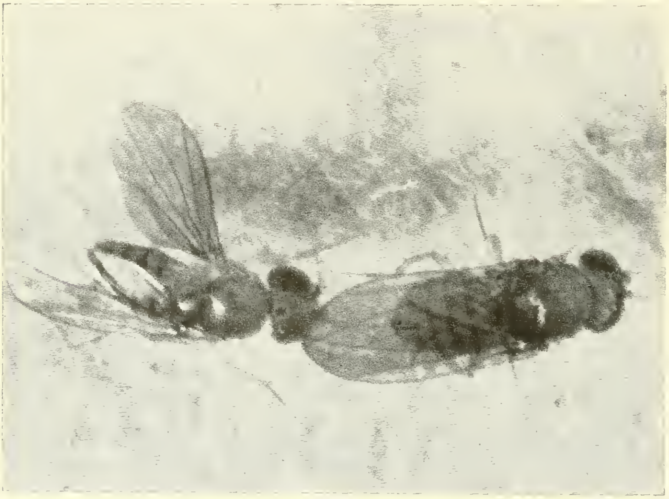
Herewith, the photographs we took of this sequence of mating behavior.



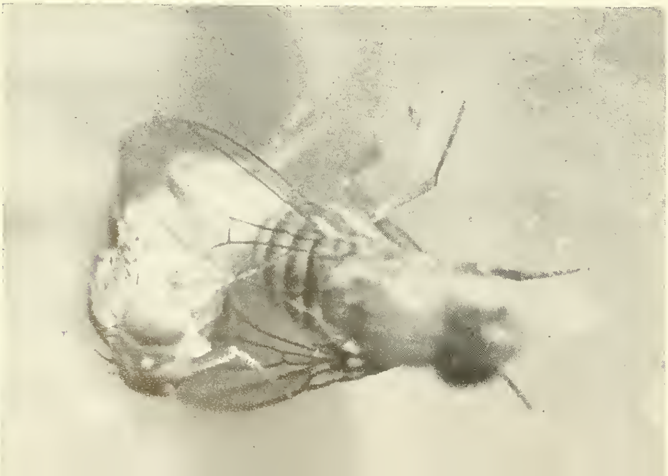
'REPARATORY TO MOUNTING, male swings to rear of female vhere he assumes a slightly crouching position. Repeated observations suggest that males frequently try to mount any object, whether a dead fly, a lump of food, or another male.

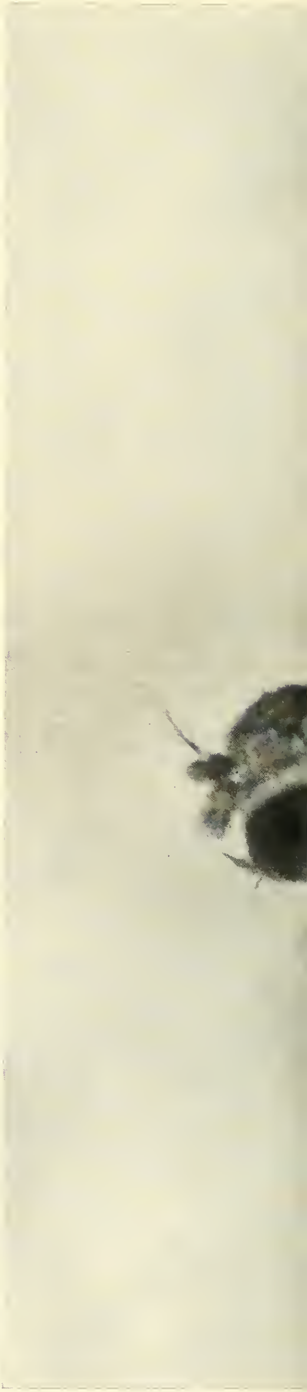


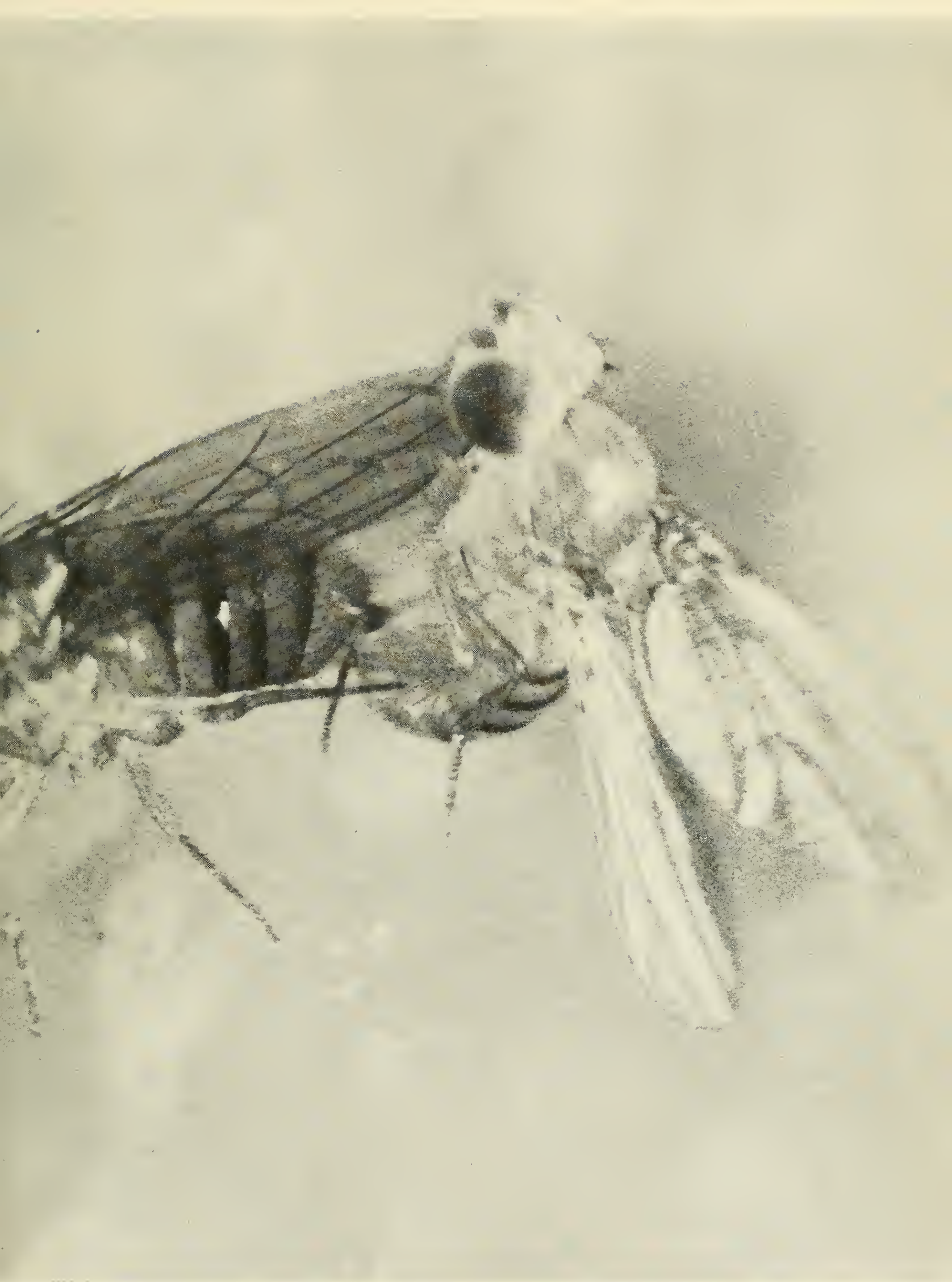
“Licking” is shown, *above*, and excited male then vibrates one wing and begins to mount, *below*. In *D. paulistorum*, the vibration is found only at this stage.



Mounting the female, *below*, the male is held between female’s slightly spread wings and uses their bases to support forelegs. Mating lasts some 17 minutes.







Termination of mount occurs when female snaps wings shut, forcing male to tilt backwards. She then shakes her abdomen vigorously, and the male soon falls off. During copulation, female may walk about or even have to fend off other males.

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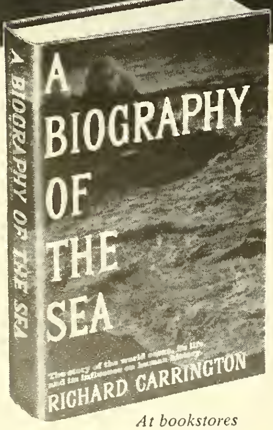

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and his family. And so he trudge
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Christos' parents married after th
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But Communist uprisings broke ou
and guerilla bands burned their hous
and all their belongings.

They began all over–from nothing
They own three pieces of furnitur
All sleep on the cold earthen floo
They are always hungry. Life is dar
for Christos now. How long can h
nurse his dreams and carry hope i
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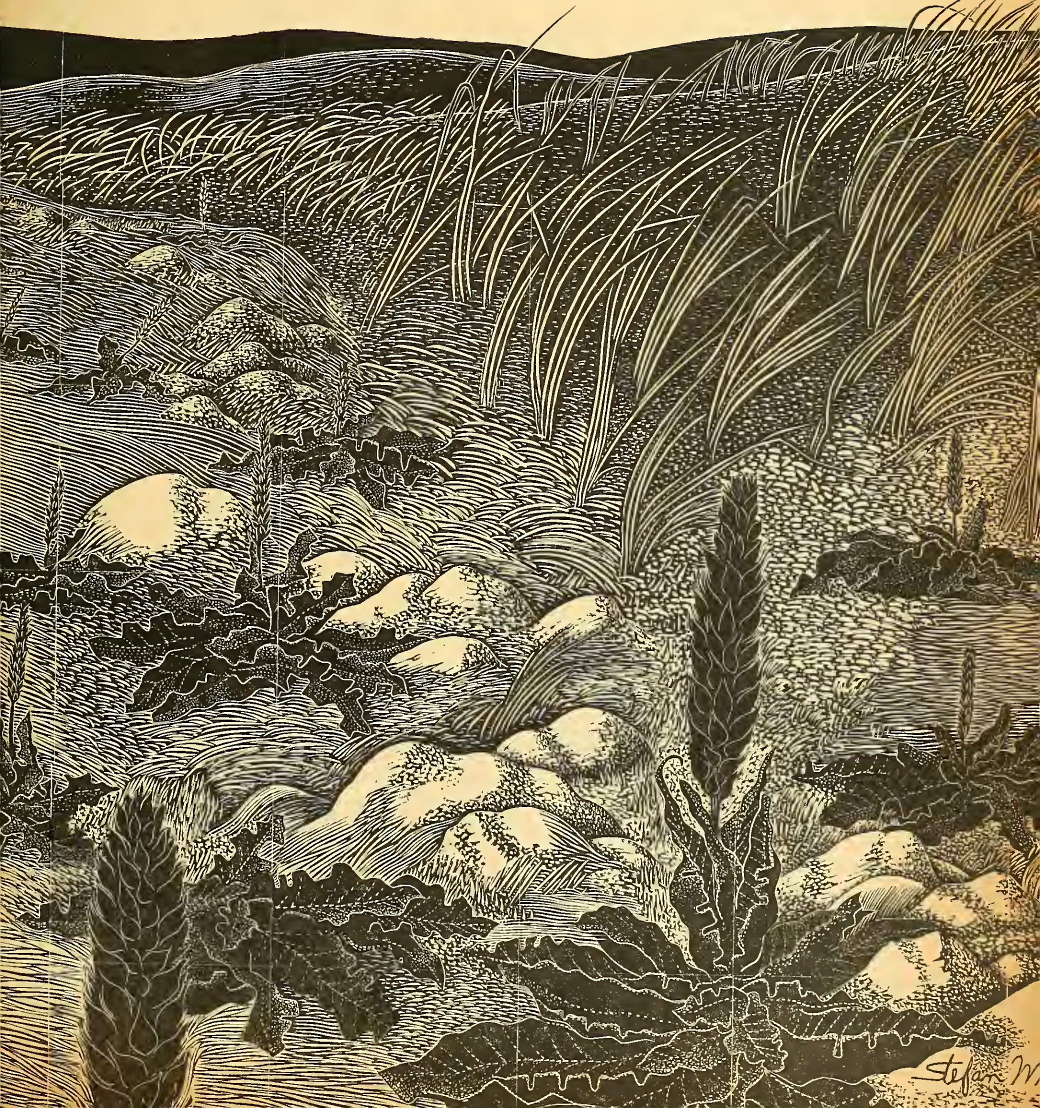
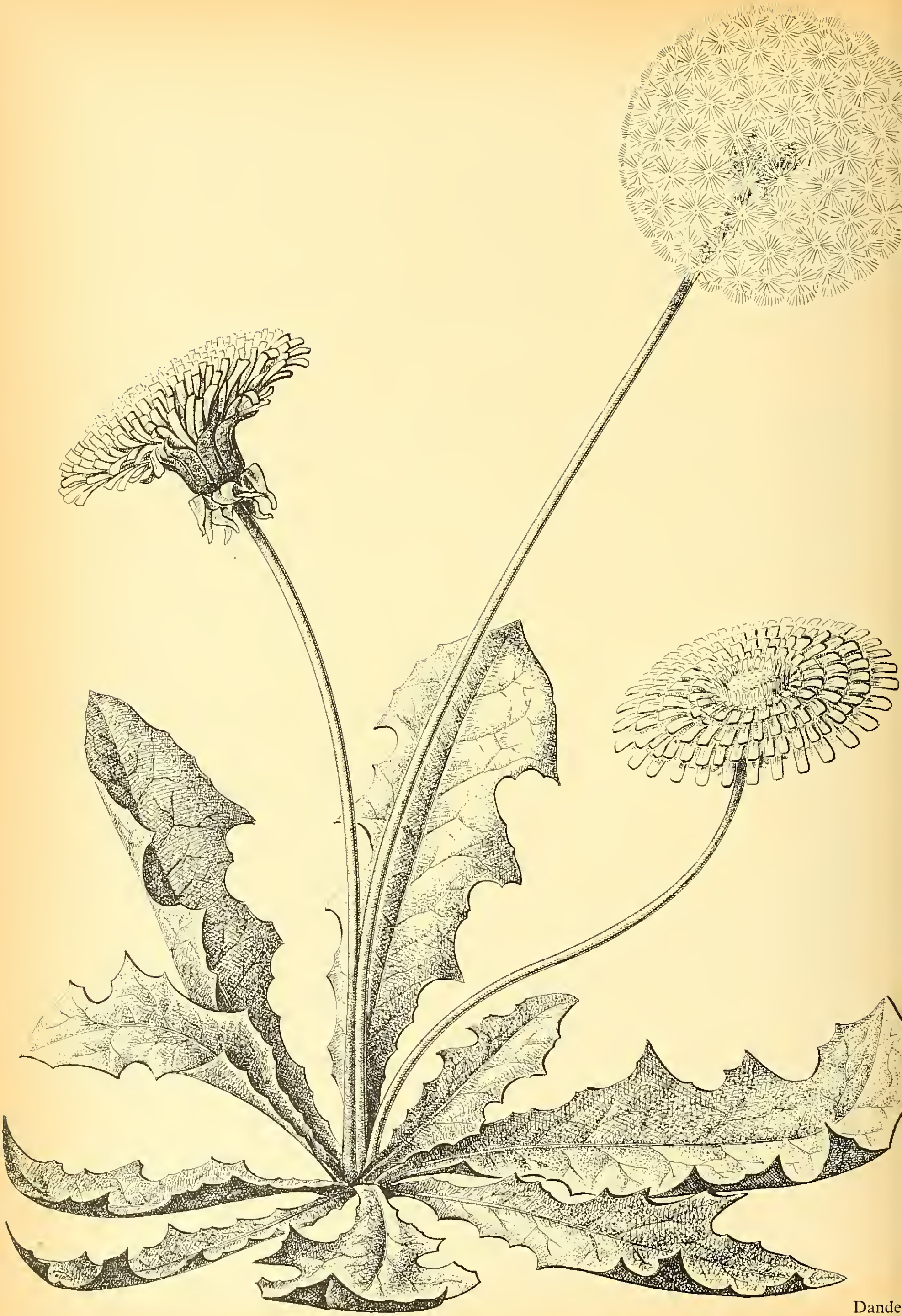




Dande

BASAL ROSETTES

asal leaf production may permit the survival of certain plants

By Dr. E. LAURENCE PALMER

IS QUITE POSSIBLE that the 108th and 109th units in this series of educational inserts may be criticized their unorthodox approach to the understanding of ure. While this particular unit deals with plants, it l not deal with plants of any specific taxonomic group, h as the legumes, the grasses, or such loose groups the nuts, the fibers, or the oil-producing plants. In- ad, we will call the reader's attention to the fact that surface of our country is covered, in part at least, by lanket of herbaceous plants—plants that have an im- tant role to play in the economy of nature.

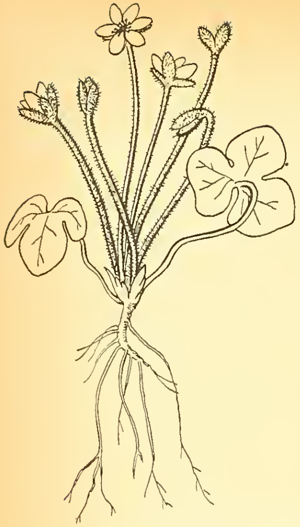
We shall give special emphasis here to those plants ose leaves lie close to the ground at the approach of ter. These are basal leaves or, in some cases, are led "rosettes." We shall not, however, confine our- ves wholly to such plants. We will point out the fact t many plants seem to "budget" their lifetimes, includ- in their budgets a time for increasing their stature, eriod devoted to preparation for the winter crisis, l a time for reproduction. Basal leaves are empha- ed now, because they are likely to be conspicuous at ut the time this article appears. The 109th insert, ich will appear January, 1961, will deal with the snow nket that later covers the plant rosettes.

When the days become shorter in late summer and ., the growth habits of many plants change. This is ticularly true of many of the herbs of field, lawn, and dside, and those of the wastelands. Instead of devot- all energy to growing tall, to increasing in stature, the production of flowers or to the ripening of fruits, se plants develop leaves, on shortened stems, that are wded close to the ground. This is particularly true of plants that do not mature their fruits the first year, but require at least a second year of growth for fruiting.

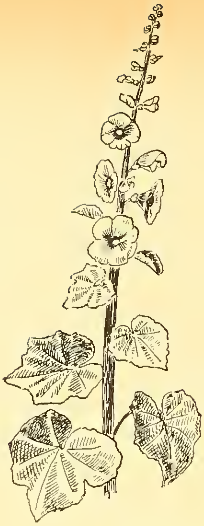
The warm soil, and the warmer air next to the soil, seem to provide an area where such plants may continue their growth when conditions would otherwise be unsuitable. It is possible that this late growth habit is associated with some nutritive deficiency, perhaps associated with seasonal changes. We know, for example, that fruit trees may develop a "little leaf" or "rosette" disease due to nutritive deficiencies, but we cannot assume that the clustering of basal leaves is necessarily associated with disease. In fact, the truth may lie in the opposite direction; the production of such leaves may furnish a technique whereby growth is continued and structures developed that permit survival and development during a time when orthodox growth would lead to destruction of herbaceous plant tissues.

Many garden plants that in early season do not develop basal leaves, but rather proceed directly to the production of flowers and fruits, may develop them late in the season. Garden soil and waste ground then may be covered with a plant leaf carpet that furnishes an interesting field for study.

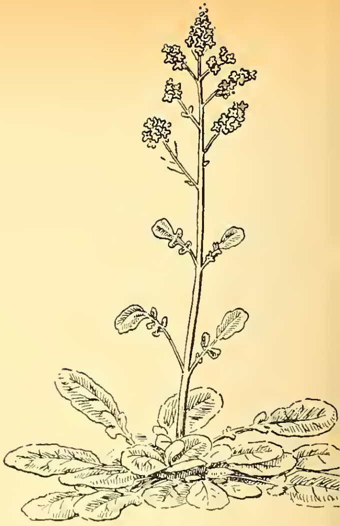
The basal leaf development may be considered as a kind of "retrenchment" technique. Starting with the crown of the stem from which the leaves arise at the surface of the ground, the basal leaves provide a maximum of exposed plant surface at ground level. The leaves can get water from the stem until conditions become too severe. The width of the leaves is generally narrowest where they are attached to the stem and expand as the distance from the stem increases.



Blunt-leaved Hepatica



Hollyhock

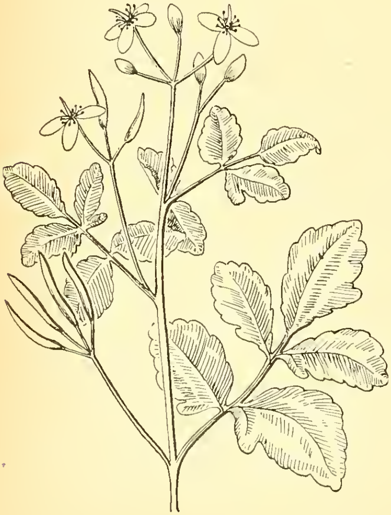


Winterc

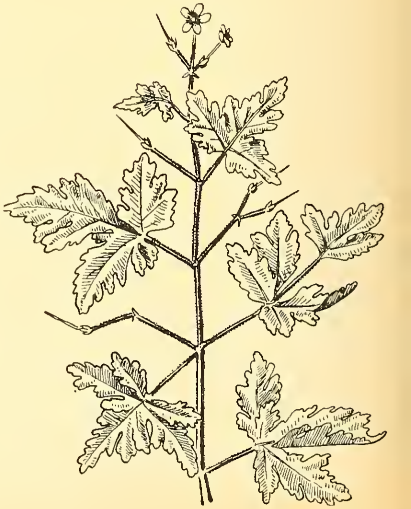
Examine with care as many basal leaf structures as can be located at this time of year. The investigator will find that many are generously covered with spines, prickly hairs, or other devices, which might tend to discourage destruction by grazing animals. It is true that some plants, like winter cress, new dandelions, and even garden lettuce, furnish tasty and edible leaves; but in some cases these developments are due to cultivation, and not to the vagaries of nature. The leaves commonly lie close to the ground, assuring the plant suitable growing conditions, and also offering protection against any animals that might seek them as food.

The leaves of many weeds provide a reserve of f
that the plant can use when it is time to put up a flowe
stem. Such nutritive wealth is naturally an invitatio
grazing animals; but protection may be afforded to s
species of plants because of their distasteful leaves.

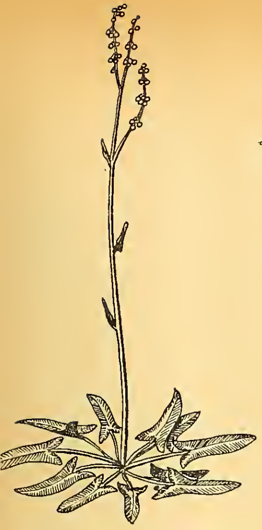
THE question of survival from animal attack may
highly critical during the late season, when availa
plant food supply lessens. Then, any green plant
be an invitation to a herbivorous animal. Fortuna
for some plants, it is not easy for certain mammal
harvest plants that hug the soil. A cow, in feeding, tw



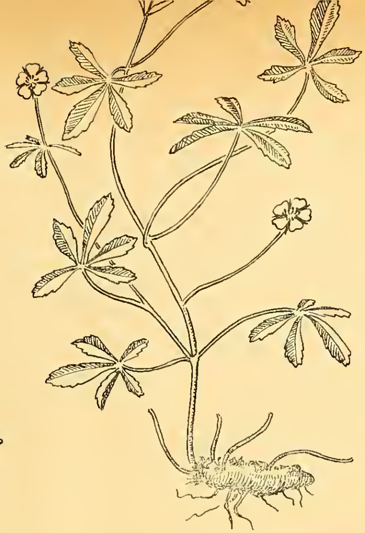
Celandine



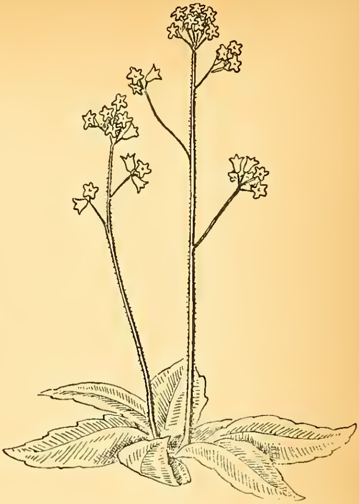
Herb Robert



Sheep Sorrel



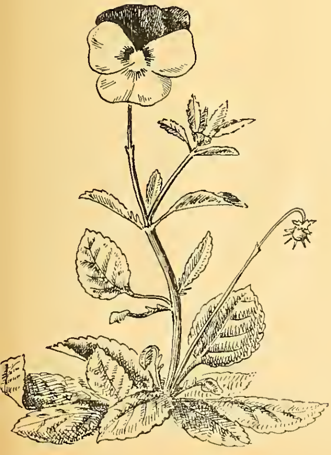
Cinquefoil



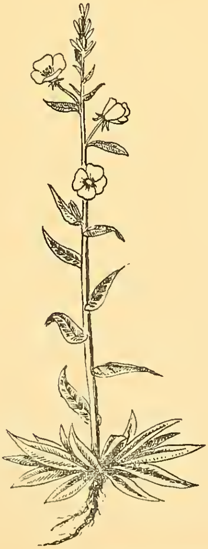
Early Saxifrage

r tongue around erect vegetation, pushes it back into r mouth, and with her lower teeth pushes it up against e pad on the upper jaw. She then breaks the plant by ising her head slightly, and finds herself with a mouthl of food. This method of feeding is of little avail where liage is close to the soil. Sheep, with smaller jaws, n graze vegetation closer than can cows; and horses, ith biting teeth on both jaws, can crop vegetation even ore closely. Even horses, however, may find difficulty getting a mouthful of food if the plant is very close the soil and rooted to it on the under surface. Plants, course, do not intelligently solve this survival problem; but a combination of circumstances may save many basal leaf clusters to produce flowers and seeds for the following year's generation.

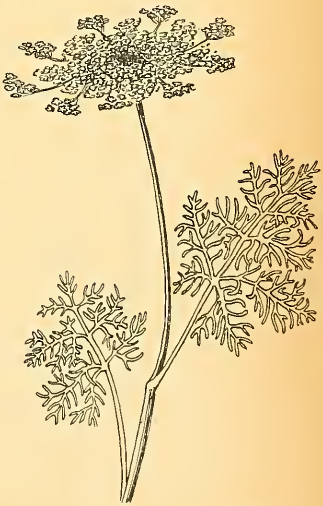
There seems little doubt that, in some plants, flowering can be induced by changing the hours of available light. Strangely enough, it seems that the continuity of the daily dark period may be more important than the total periods of light or darkness, and that exposure to light for a minute — or even less — during the normal dark period may have a remarkable effect. Florists use a knowledge of this fact to control the bloom of flowering plants, so that blossoms may be at their best and



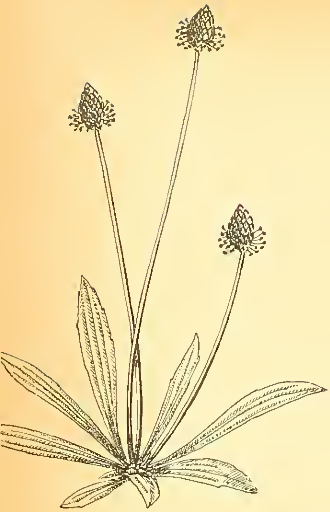
Pansy



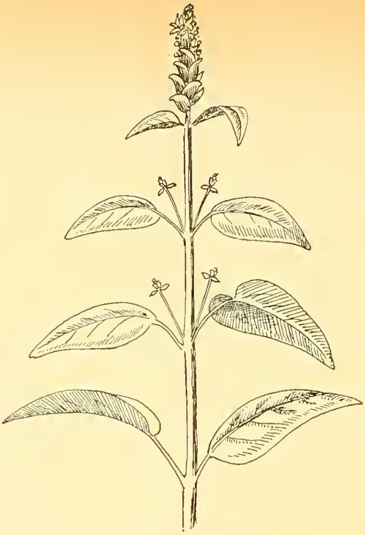
Evening Primrose



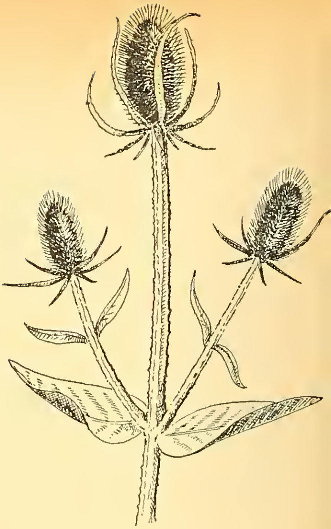
Wild Carrot



Narrow-leaved Plantain



Heal All



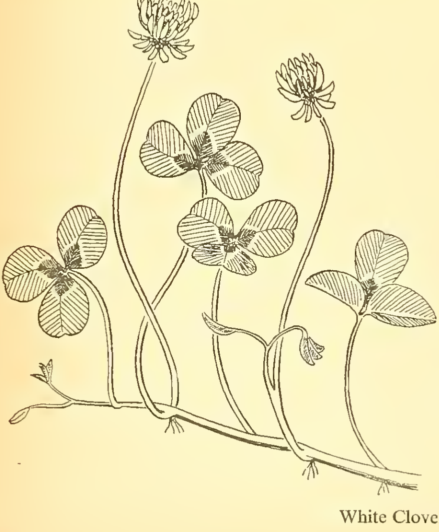
Teas

most abundant when market values are at their highest.

The development of plants in fall—and, of course, at other times as well—is greatly affected by the nutriment available in the form of natural or artificial fertilizers. The introduction of extra nutriment into the soil at a time when it is naturally decreasing finds an expression in plant growth. Animals may also affect plant development, both naturally and under controlled agricultural conditions. In the North, for example, snowy owls commonly feed on rodents. These little mammals are captured by the owls, who usually take them to a nearby perch to be eaten. After the meal, the birds may discharge their droppings before setting off on another hunt. Other birds feeding over the same territory may rest ai
fertilize the same spot, with the result that the soil b
comes richer for the plants growing there—often co
spicuously so. Mice collected over a considerable territo
may thus enrich the soil of a limited area.

Observant persons who visit pastures where domes
mammals are allowed to forage know that, where the
are cow droppings, a rich growth of plants is likely
appear, particularly if cows are the only mammals pre
ent. Cows apparently do not relish plants that ha
recently grown from their own excrement. Horses beha
in the same way in their own pastures. If cows and hors
are allowed to graze in a common field, the cows fe
readily on plants nurtured by the manure of horses, wh
horses feed readily on plants nourished by cow dro
pings. It seems likely that the habit of avoiding conta
with one's own body wastes is bound up with the fa
that many animal parasites are freed with the wast
Many such parasites are specific, and animals that avo
their own discharges are therefore less likely to becor
infected with their specific parasites.

A study of the varied growth of plants is often of val
in plant management practices. As we alrea
mentioned, rosettes and other unusual plant develo
ments may be due, in part, to undernourishment. E
cause of this, the plants lie flat; and, because they
flat, they cannot be cropped by grazing animals. Su
pose we reverse the situation. What happens? If po
land is enriched, the plants grow more vigorously. T
neighboring plants also develop, and competition ensu
The plants become so crowded that they can no long
lie flat, for lack of the necessary room. The leaves a
forced into a more erect position. As a result of this
grazing animal can then feed on the plants. The we
plant cannot stand the competition, and it disappea
This may help explain why plants with basal leaves
rosettes appear so commonly on less productive lan



White Clover

Many weeds make basal leaf structures that compete too successfully with more desirable plants. Along e edges of most sidewalks may be found the sprawling nains of knotweeds, spurges, and similar plants whose s have spread out over the bare concrete. Often y form mats that can be easily lifted from the side-lk, although the aboveground parts of the plants are ually attached to a deeply penetrating root system. is type of root is able to penetrate far into the ground ring periods of drought, and because of this the weed rvived while many of its associates perished.

Such weeds may provide food for some of the smaller rds, like sparrows. Their deeply penetrating root sys-ns may permit water to seep through layers of other-se impenetrable soil. They may also serve to slightly duce the temperature of the soil in which they grow, d thus in some measure may reduce the loss of soil-ter during extremely hot weather.

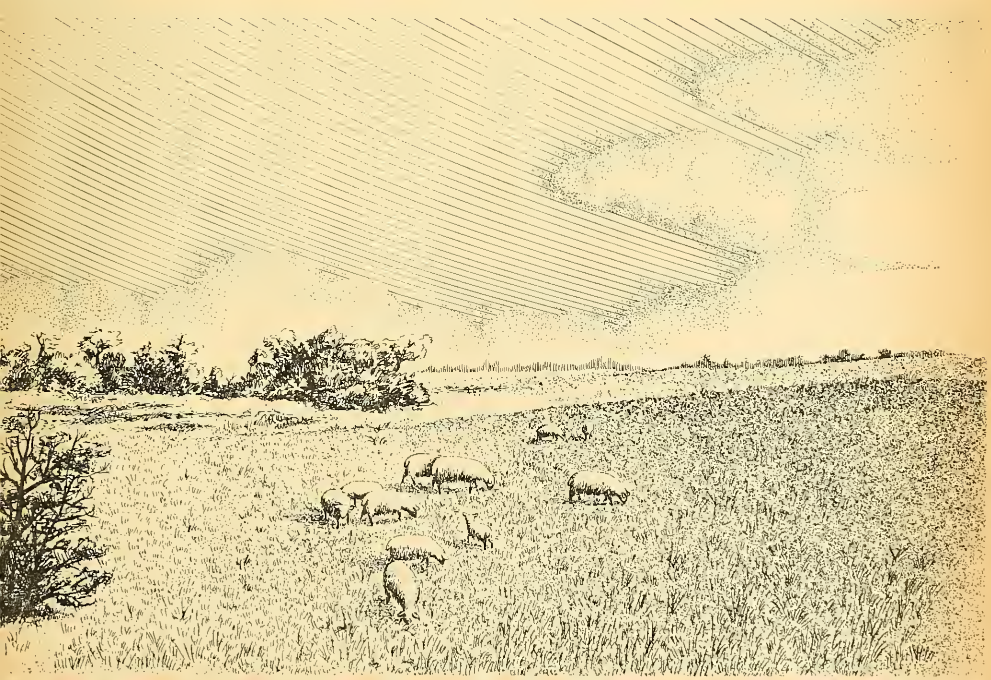
THE underground parts of plants composing the vegetative blanket are most important. They penetrate e soil, breaking it up to admit water, plant, and animal atter to enrich the soil. Underground parts of plants ay survive fires, floods, the impact of herds of migrat-g animals, sudden increases in the abundance of de-uctive insects and fungi, or even the cultivation prac-es associated with agricultural management. A fire at burns the aboveground parts of a plant leaves the ried parts still rich in food, and capable of developing thout the top that in summer was so necessary. Thus, ch a plant is not easily destroyed. This underground ritory is a remarkable refuge in time of trouble for plants, and because of its unusual wealth of food resources it is also a treasure house for animals that are able to make use of it.

DR. E. LAURENCE PALMER, for many years director of NATURE MAGAZINE'S educational program, continues his special inserts in the pages of the combined magazines.

We see, therefore, that during the fall there is a blanket of plant material on the surface of the soil, and another blanket of stored food just beneath the surface. It is because of these reserves that flowers bloom with the melting of the snow in spring, and vigorous plant growth springs earlier from germinating seeds.

With a knowledge of the problems and the nature of the basal leaf- or rosette-producing plants, and how they may be encouraged and discouraged, it is possible to control their development to man's advantage. We know when it is best to harvest underground root systems. We understand not only why fires may be helpful in destroying insects and weed seeds, but also how the destructiveness of a fire may be controlled. We may observe the role of the vegetative cover in providing food and shelter for animals, and, if we are ingenious, we may find both commercial and entertainment values in such plants. Many of them are of great value because of their beauty; others have played parts of greater or lesser importance in the arts, industry, and medicine.

Politicians and sociologists may argue the merits of the "one world" idea, but biologists and naturalists recognize the fact that there are many worlds that we must understand and control if mankind is to survive. Few of these smaller worlds can be profitably ignored.



osettes often lie flat on poor land from undernourishment. On better soil they grow more erect, so can be grazed off.

	DESCRIPTION	RANGE AND RELATIONSHIP
Sheep Sorrel *Rumex acetosella*	Basal leaves appear on branching, tough rootstocks at intervals. Leaves grow to about 5 inches long, but usually shorter; long-stalked, with blade somewhat like arrowhead, to 1 inch wide, smooth, sour, with veins grooved; annual or perennial. Stem slender, erect, smooth, to 1 foot high.	Order Polygonales. Family Polygonaceae, including rosette-forming curled dock, *R. crispus;* smooth dock, *R. altissimus;* smartweeds, *Polygonum* sp.; beets, rhubarb, buckwheat. Sheep sorrel found in North America, except in far north; apparently introduced from Europe, but also found in Asia.
Blunt-leaved Hepatica *Hepatica americana*	Basal leaves, with old leaves surviving winter to be replaced in spring by new set. Leaves with long, hairy stems and leathery blades which are 3-lobed, with lobes pointed. Leaves to 2½ inches broad, which, when mature, rest on ground. Apparently stemless. Roots fibrous and profusely branched.	Order Ranunculales. Family Ranunculaceae, of about 40 genera and some 1,500 widely distributed species, including such common plants as the buttercups, anemone, clematis, cowslip, pasque flower, wild columbine, peony, larkspur, locoweed, and baneberry. Hepatica found from Alaska to Florida.
Celandine *Chelidonium majus*	In fall and winter leaves lie flat on ground, are up to 8 inches long, almost twice compounded into 5-9 segments with basal units opposite but leaves alternate. Veins large and conspicuous. Stem to more than two feet high in summer. Plant rich in yellow juice, which has some poisonous properties.	Order Papaverales. Family Papaveraceae. With about 26 genera and more than 400 species native of north temperate America and Eurasia. Celandine ranges from Quebec to Georgia, and west to Iowa and Missouri. Relatives include herbs and shrubs; also poppies, bloodroot, and the prickly poppy.
Early Saxifrage *Saxifraga virginiensis*	Conspicuous basal leaves crowded together in spring. Leaves to over 3 inches long, with narrowly margined petioles, irregular margins, and conspicuous midribs. Stems to 1 foot high, but usually lower and branching above to form flat-topped clusters. Roots matted and usually buried in wet earth.	Order Rosales. Family Saxifragaceae. About 80 genera and over 1,000 species in the family, highly cosmopolitan but at best in temperate and arctic areas. Family includes hydrangea, mock orange, bishop's cap. *S. virginiensis* ranges from New Brunswick to Georgia, Tennessee, and Minnesota.
Winter Cress *Barbarea vulgaris*	Winter basal leaves close to the ground, conspicuous in winter and in spring. Leaves in winter and spring bright green, with terminal lobe much the largest and the secondary lobes of 1-4 usually opposite pairs. Leaves are alternate with lower well-petioled. Stem to 2 feet high in summer and fall.	Order Papaverales. Family Cruciferae. Mustard family includes over 350 genera and over 2,500 species; many closely associated with agricultural crops as weeds, but some of recognized agricultural value either as direct food or as sources of commercial products of value in arts and sciences.
Cinquefoil *Potentilla canadensis*	Bunches of leaves arise from points where the sprawling horizontal system touches the ground and where it may take root. Runners may be over 2 feet long. Leaves of 5 leaflets, each sometimes to over 1 inch long and over ½-inch wide, with saw-toothed margins, usually lighter on undersides.	Order Ranales. Family Rosaceae. About 100 genera and 5,000 species in the family, of which some 300 are in this genus with some 215 in North America. Family includes roses, most orchard fruits, and many herbs, shrubs, and trees. *P. canadensis* ranges from New Brunswick to Georgia and west.
White Clover *Trifolium repens*	Sprawling plant that roots freely at stem joints and forms dense mass of foliage not necessarily in rosettes but in rather solid turf. Leaves of 3 small leaflets, smaller than those of alsike, red, and other clovers, with glossy undersides, margins finely notched, tip slightly notched, and petioles long.	Order Rosales. Family Leguminosae. Family includes the legumes of great importance as food and soil builders. White clover is varied, including wild white clover of North America and Dutch and Ladino of Europe, each with specific values; survival needs must be recognized and maintained.
Herb Robert *Geranium robertianum*	Plant may sprawl or stand erect, and in late fall may be conspicuous because of bright red color, sometimes covering the ground. Stem height to 1½ feet. Plant strongly scented, and with sticky hairs. Leaves finely cut and with 3 obscure parts, sometimes 5, with divisions sometimes twice divided.	Order Geraniales. Family Geraniaceae. Family includes 11 genera and some 650 species, with wide world distribution, varied habits; includes herbs, shrubs, and other woody annual or perennial plants. *G. robertianum* found in Europe, Asia, America, Africa —range: Nova Scotia to the Southwest.
Hollyhock *Althaea rosea*	Conspicuous, fall basal leaves are formed. Leaves also borne along erect stem, which reaches height of 9 feet. Leaves are long-petioled, rough, deeply veined, 5-7 lobed or with wavy margins, alternate, in general round to heart-shaped blades. Root system is deep and, usually, quite heavy.	Order Malvales. Family Malvaceae. Included in family are cotton, jute, and rose of Sharon; in the order are cocoa and kapok. About 15 species of the genus found in temperate parts of Old World. Hollyhock is of world-wide distribution both in cultivation and as an escape, and is a native of China.

REPRODUCTION	ECOLOGY	ECONOMY
Staminate and pistillate flowers borne on separate plants, blooming May–September, in small clusters on terminal branches. Pollen windblown; chromosome number 42. Fruits tiny, brown, obscurely 3-angled, partly calyx-enclosed. From seed to seed in a few months, but seeds are hardy.	Used as an index of acid soil, and does well where there is little water. May serve in minor way as soil anchor. Seeds and plants survive drought well, and plants may grow on soil that will support few other plants. May be controlled by enriching soil with fertilizer, applying lime, or drying roots.	Vigorous spring or autumn leaves good raw, or cooked with cream sauce, or in soups that may otherwise taste flat. Leaves may cause dermatitis in humans, and animals with low calcium diet may be mildly poisoned by eating leaves. Does not survive competition by grasses, clovers, or other forage.
Flowers, attractive long-petioled saucers to 1 inch across; blue, purple, or white-flowering from December through May, often under the snow. Petals are absent, replaced by up to 15 colored sepals and a few green, sepal-like involucre bracts. Stamens and pistils distinct and numerous, with 1-seed fruits.	Favors acid soils, while the blunt-lobed *H. acutiloba* favors limy soils. Tannin extracted by alcohol from full-grown leaves has slight astringent value, but its reputation for stirring up the liver in spring is not well founded. No medicinal value is now recognized in preparations made from this plant.	Primarily a thing of beauty, with flowers that may be picked with little likelihood that the plant will be destroyed. It is so popular that it is the state flower of Missouri and Minnesota, and is so closely like the European *Hepatica nobilis* that some question any difference whatsoever.
Flowers of celandine are yellow, to ¾-inch across, borne on loose, open clusters on slender, branching stems tending to become erect. Sepals 2. Petals 4. Stamens many. Fruit a slender, 2-inch capsule, which opens to free many shining, crested seeds. Flowers from April through September.	Chromosome number usually 12. Plant common in old gardens and cemeteries, along old paths, in sun or shade, and common around abandoned country homesites. Considered as ornamental by some, with reservations. Once established, it may be long persistent, but yields quickly to cultivation.	Juice and parts generally contain alkaloids chelidonine, protopine, and chelerythrine, and may be used as diuretic or purgative; juice may cause a rash on skin of children, who enjoy painting themselves with it; but individuals vary in their sensitivity to it. Not a serious poison, ordinarily.
Flowers about ¼-inch across, with 5 greenish-white petals, 10 stamens, and 2 carpels in fruit, and with petals about 2 times the length of the sepals. Yellow of stamens almost as conspicuous as white of petals. Common reproduction by spreading underground parts, so plant occupies a small, dense area.	May mat dry ledges in ravines where the rocks are not calcareous or where there is sandstone, clay, or gravel; but not lime. May sometimes be found in open woodland. Pollination is caused by insect visits, probably most commonly from March through May, or into early summer.	Young, uncurling leaves of a number of saxifrages are eaten as a salad or as a part of a mixed salad, but with no particular value – and apparently with no danger. The related *S. pensylvanica* is reported to have roots of food value, but they are too small to ever be of any considerable importance.
Bright yellow, ⅓-inch flowers appear near end of developing stems, with the youngest at the top. Each borne on stout, individual stems, in cluster; and producing a fruit that is roughly six times as long as supporting stem. Stamens 6. Fruit to more than 1 inch long, splitting open to free seeds.	Grows vigorously in warm periods in winter to form conspicuous rosettes, which are edible as early as December, tasting like good dandelion greens. May be repeatedly boiled and salted to remove bitterness and to suit individual taste, but should be eaten soon after preparation to be at best.	Farmers control plant to a degree by cultivation of soil late in season to destroy leaves, or by spring cultivation; or by use of the standard herbicides when other methods fail. Seeds are long-lived so crop rotation has its limitation where abundance is great. Arists may see beauty in plants en masse.
Flowers are yellow discs, to ½-inch across, composed of 5 petals, 5 sepals, and many stamens and carpels. Flowers arise usually singly from bases of leaves' axils, and fruit appears to be bunch of dried "seeds." May reproduce by separation of parts of the runner. Seed from June through September.	A poor competitor for more useful plants, and so may be common on such poor soil as cannot support good forage crops. Considered by many as an indicator of poor soil fertility and of sour soil, and an indication of soil not suitable for forest plantings. Almost always survives drought well.	Management is effected usually by use of fertilizers that encourage competition from more useful plants, and by encouragement of clovers and similar plants that enrich the soil. May serve to a degree as a minor soil anchor, but of course is inferior to more useful plants, even in this respect.
Flowers in small, whitish, globelike clusters, to ½-inch long, with corolla 2 to 3 times as long as the calyx; flowers sometimes pinkish. Chromosomes, 32 or 64. Flowers from May through December, and when pollination is effected the flowers droop. Pods, each with 2 or more yellow seeds.	Usually wild white clover used in pasture or lawn mixtures, with 1 lb. of clover added to 2 lbs. grass mixtures; the clover should be properly innoculated with bacteria to grow. Seed may be buried by not over ¼-inch, with rolling usually being adequate. Yield is best from grass and clover mixture.	White clover grown for pasturage, for soil enrichment, or for soil anchorage. Wild white clover may last 3-6 years, but plant is low with deep taproot. Ladino white is largest and may survive to 6 years. Dutch white may produce abundant forage, but may last only 1 year, so treatment varies with need.
Flowers appear from May through September – pale pink to magenta to white, to ½-inch across, with petals 1½ times as long as sepals. Stamens 10. A fruit with sharp point and length to 1 inch splits from base to free seeds which are hurled into air. Fruit is almost smooth; looks like crane's bill.	Chromosomes, 32. Related storksbill, *Erodium cicutarium*, is occasionally used as a salad, but for most part the geranium family is not edible, perhaps because of the usual strong odor–even cattle avoiding the musky plants as food. Except as ornamentals, few of this family are economically important.	The best known economic relative is the house geranium, *Pelargonium* sp., commonly used in schoolrooms and homes for simple experiments in plant physiology. Commonest form of reproduction is by division and planting of slips. Oil from some species has commercial value because of fragrance.
Flowers are showy and to more than 3 inches across, with many stamens united in a tube through which the tips of the pistils are thrust and around which the showy corolla is found. Latter is found in many colors. Seeds are abundant in a disc around a central axis, and become freed as segments.	May be annual, biennial, or perennial but rarely annual, blooming in July to September or later. Is self-sowing. Young plants need a protective mulch under severe weather conditions. Seeds may live to 5 years when dry, and may germinate in 5 days. Plants are highly susceptible to fungus attack.	Used primarily for tall background borders in flower gardens. Most insect pests are controlled by sulfur dusting, and many fungus pests by spraying with Bordeaux solution. Some varieties are resistant, but an infected garden spot should be avoided, if possible, until the insect pests have died out.

	DESCRIPTION	RANGE AND RELATIONSHIP
EVENING PRIMROSE *Oenothera biennis*	Conspicuous fall and winter basal biennis leaves up to 6 inches long and to 1½-inches wide, pointed at tip and with clasping base. In the winter, with the midrib characteristically pinkish, the leaves turn partly red at complete maturity. Stem is to more than 6 feet tall; slightly, or not branched.	Order Myrtales. Family Onagraceae. Included in the order are eucalyptus, fireweed, water milfoil and myrtle, and bay. There are some 30 genera and 600 species in the family. Evening primrose, *O. biennis,* ranges from Labrador to Florida and west to the Pacific, with close European relatives.
WILD CARROT *Daucus carota*	Lacy basal leaves in fall, which are finely dissected, alternate, strongly scented when crushed, usually a pale green, with the smaller units conspicuously saw-toothed on margins. Biennial. Erect mature stems to 3 feet high and crowned with flat-topped flower cluster, repeatedly compound.	Order Umbellales. Family Umbelliferae. Commonly called Queen Anne's lace. Order includes poisonous water hemlock, parsnip, and celery, all in Family Umbelliferae, and the dogwoods in a closely related family. *Daucus* is native of Asia, from Coast to Coast. Genus has 25 species.
GARDEN PRIMROSE *Primula polyantha*	Basal fall leaves are most conspicuous, with leaves to 6 inches long; narrow, with winged petiole, wrinkled, with impressed veins and inconspicuously uneven margins. Mature plant in summer may be to 1 foot high. Basal leaf clusters show in the late fall and in the early spring of the year.	Order Primulales. Family Primulaceae. The family includes, in addition to the primroses, such ornamentals and otherwise economic plants as rock jasmine, cyclamen, shooting star, loose-strife, and pimpernel. The family includes about 90 genera and 800 widely distributed species. A hybrid.
PANSY *Viola tricolor*	This common annual or short-lived perennial produces masses of leaves which may persist under the snow, and many of the species bloom often at the very edge of the snow. Leaves, long-petioled with heart-shaped blades. Stem leaves are narrower. Height of stem is about 6 inches.	Order Violales. Family Violaceae. The order includes, in addition to the violets, the begonias. The family includes herbs, shrubs, and even trees, belonging to some 15 genera and more than 400 widely distributed species. Many pansies may escape from cultivation and survive for a while "on their own."
HEAL-ALL, SELFHEAL *Prunella vulgaris*	Underground rootstock produces bunches of leaves near ground which may have rosette functions, qualities. Leaves are opposite, to 4 inches long, petioled, with larger leaves above. Stems are square, sometimes branched, rooting at joints to form clear stand, crowding out competition.	Order Polemoniales. Family Labiatae. Family includes the mints, which in turn includes herbs and shrubs of about 160 genera and some 3,000 species, exclusive of horticultural forms. Heal-all is native to Europe, but widely established in most of North America, where it is probably native. Also Asiatic.
MULLEIN *Verbascum thapsus*	Fall rosettes of densely furry, pale green, alternate leaves with broadly margined petioles, each to 1 foot long and half as wide, in summer and fall lying close to ground. Stem is erect, to 8 feet tall, and longitudinally fluted by leaf bases that extend down the stem. Erect stem forms second year.	Order Polemoniales. Family Scrophulariaceae. Order includes the borages, mints, verbenas, and such economic plants as potatoes. The family includes about 190 genera and some 3,000 species of herbs, shrubs, and trees with alternate or opposite leaves that are widely distributed over the earth.
TEASEL *Dipsacus sylvestris*	Large, spectacular basal leaves appear in late summer and fall. Leaves are opposite, bright green, joined at bases to form cups on the stems. Leaves are prickly on midvein beneath, and rosette leaves may be to more than 1 foot long. Root system penetrates deeply and coarse stem is to 6 feet high.	Order Rubiales. Family Dipsacaceae. Order includes coffee, gardenia, honeysuckle, and other plants. Family includes the teasel and *Scabiosa.* The teasel family includes some 7 genera and 140 mostly Old World species. Some now established on world-wide basis. Teasel includes 13 species.
NARROW-LEAVED PLANTAIN *Plantago lanceolata*	Conspicuous fall basal leaves: crowded, narrow, and heavily veined—each to 1 foot long and to 1 inch wide, being usually widest above the middle. Stem above ground is short or apparently absent, and fed by numerous fibrous, seemingly shallow roots that are difficult to pull up and may break.	Order Plantaginales. Family Plantaginaceae. Only one family, which includes 3 genera and about 260 species of little economic value: some pernicious weeds. *P. lanceolata* is native of Europe, Asia, and is found in America from New Brunswick to Florida, west to California, British Columbia.
DANDELION *Taraxacum officinalis*	The rosette of leaves, close to the ground, arises from a deeply penetrating taproot. The leaves are highly variable, and up to 10 inches long. Their margins may be almost entire, but are usually deeply toothed. The common name refers to a fancied resemblance of leaf-teeth to lion teeth.	Order Campanulales. Family Compositae. Order includes families in which gourds, bellflowers, and lobelias are found, as well as the composites. Composites include herbs, shrubs, few if any trees. There are likely 800 genera, 20,000 species. Authorities claim 50 to 1,000 species of *Taraxacum.*

REPRODUCTION	ECOLOGY	ECONOMY
Flowers are showy, pale yellow, opening at dusk to 2½-inches across, and with elongate basal tube. Sepals, 4; petals, 4. Stamens, 8, of equal length to that of the pistil. Pollination is effected by visiting insects or by self, with chromosomes numbering 14. Seeds are abundant, and are freed slowly.	Basal leaves flatten with the shortening of the days in latter part of year. Usually "rosette" is formed first season and tall plant the second year. DeVries used the related *O. lamarkiana* as an important basis for his theory of evolution, which involved mutants as highly significant phenomena.	Roots of early spring leaves may be collected and cooked to form a parsnip-like edible dish, but it may be necessary to use two or more changes of water to get rid of the bitter taste. Properly prepared, it is a good food and well liked by some. Best roots are second year roots, sliced and boiled.
Flowers small and borne in compound formation that is to 4 inches across, which opens and closes with change in humidity. Some of the rays may be more than 2 inches long. There may be a central flower—black or deep purple. Fruits are oval, lopsided, bristly-streaked, to 1/5-inch long; hardy.	Insects may assist in pollination and may possibly be attracted by odor of the whole plant. Chromosomes number 18 or 22. Wet leaves may cause dermatitis. Seeds remain virile in soil for many years, and their production should be prevented. Cultivation and hoeing may help in control.	Edible garden carrots may be considered a variety of the type species. They have high commercial value and affect the soil chemistry greatly. 10 tons of commercial carrots may remove 100 pounds of potash, 32 of nitrogen, and 18 of phosphoric acid from the soil. Yield is low from acid soils.
Hybrid ancestry usually includes *P. vulgaris* and *P. varis*, in both of which the chromosomes number 22. Flowers are borne in rather close clusters at top of flowering stems although some bear single flowers. Flowers are double or single, white, red, purple, maroon, yellow, bronze, or mixed.	Seeds sown in greenhouse from February to May may bloom Christmas. Seedlings do best in half-leaf-mold and half-sand mixture; 3-leaved seedlings may be set in 2½-inch pots, and in August reset in 6-inch pots with rich fertilizer. Plants held at 45° F. may be forced into flower by warming.	One species, *Primula obconica*, may cause dermatitis if the leaves are handled. *P. malacoides* may be sold as a cut flower. Most common use of this plant is for borders in open gardens, where the basal leaves survive the winter and contribute to the early flowering habit of the plant.
Flowers are broad "facelike" structures to 2 inches across, usually in blue, yellow, or white, and mixed colors. A spur is associated with nectar sought by insects that help effect pollination. There are 26 chromosomes. Some flowers do not open but remain close to ground, and are self-pollinated.	For spring blooms, seeds are sown in frames in August and seedlings are transplanted to 3 inches apart. Flowers should be picked if flowering period is to be prolonged, and flowers picked in early morning before insect pollination do not wilt so quickly. For fall blooming, sow seed February to June.	Plants are always popular, and find ready sale for use in window boxes, borders in flower gardens, and for similar purposes. Well-rotted manure used as a fertilizer stimulates superior blooms. Pollination in nature is mostly by visiting bumblebees, but pollination is not necessary for some purposes.
Flowers are borne in compact, erect spikes more than 1 inch long and to ½-inch thick. Individual flower is to ½-inch long, and may be blue, purple or white, backed by green or purplish calyx. Fruit is brown and pointed. Many hardy brown seeds with a small point at one end. Chromosomes, 32.	Reputed medicinal properties implied by common names are probably wholly imaginary. Neither is the plant recognized as having food value to man or beast. It is not as fragrant as many of its relatives. It may become a most unsightly weed in the yard, particularly in areas protected from the sun.	Sprays of iron sulfate and 2-4-D are recognized as effective controls even when used at low concentration, although some contend that badly infested lawns may better be dug up and started again. It is doubtful, however, whether such a rigorous control measure is actually a necessity.
Mullein is a native of Europe, Asia, and is well-established in America as a weed from Nova Scotia to Florida, west to California, and to the north. It is a biennial, with flowers borne in crowded spikes at end of erect stem, flowering from July through September and producing a host of small seeds.	Pollination is effected by bees or by self, and is effective. Hairs may cause a dermatitis in humans, and may make plant distasteful to livestock who avoid it to the profit of the plant. Low fall rosettes are not convenient forage even if they were attractive to stock. Favors sunny exposures and dry lands.	Chromosomes, 34 or 36. Ability of the deep taproot to reach water helps plant survive droughts fatal to competitors. It has sometimes been considered of medicinal value, but this is questionable. Plant may swarm with minute, almost black, thrips, which crawl about actively in the felt of hairs.
Flowers of *D. sylvestris* borne in prickly spike, with those halfway up to flower and mature first. Corolla is pale blue to purple, to ½-inch long, 4-parted with attached calyx. Fruits are dry and four sided, and are protected in part by spiny spike which in related species has commercial value.	Chromosomes number 18 in most species of the genus, including *sylvestris*. Plant is a biennial, producing the rosette-bearing plant in the first season and sending up the fruit-bearing stem the second. Juice has a disagreeable taste that discourages cattle and protects the plant; but it has many pests.	Related *D. fullonum* was formerly used extensively in carding wool but has been replaced by superior metal substitutes. Plant has a rugged beauty that is not appreciated by farmers, who prefer that their fields yield superior crops and who resent the competition. May be a sign of poor farming methods.
Flowers borne in short, dense spikes at end of long, flexible, slender, stems that may exceed 1 foot in length. Stamens mature after the pistils, appearing in older spikes and parts of spikes. Pollination is by wind or insects, and two boat-shaped seeds are freed from mature capsules. 12 chromosomes.	Survives drought and flood, and seeds are hardy for long periods, so plants should not be allowed to bear fruits. Is common in many lawns in late summer and fall when the other plantains may also mature. Broad-leaved plantains are common in waste places. No medicinal value is now recognized.	Control is by common weed sprays, by cultivation, and, of course, by hoeing and grubbing. Fruiting spikes are often able to survive passing lawn mowers, and they provide a welcome source of seed food to some birds late in the season. Seeds are a recognized impurity in grass seed.
Flowers borne in compact heads bound by green involucral bracts, on a broad receptacle at end of hollow stemlike scape. Flowers are yellow, straplike, of a kind, each bearing a pistil and set of stamens bound in circle by anthers. Pollen may be sterile; pollination not needed to produce seed.	A most persistent weed that can be controlled by better weed sprays, or in part by digging, or by salting the crowns. Because of new seedings, vigilance must be kept over the years. Young, vigorous tops are used to make greens, and dandelion wine is well known. Chromosomes 16, 24, 32 or 48.	Few fields of biology cannot find in the dandelion a series of interesting problems, whether concerning plant economy, food value, genetics, distribution, anatomy, or chemistry. Few plants have more unsolved problems for botanist, farmer, and layman, and few plants are so misunderstood.

nature IN THE SCHOOL

SCHOOL PROGRAMS are full of suggestions designed to help the students understand things that happen in autumn in the vegetative cover of our earth. There was a time when most schools put a large part of their time in studying seed dissemination—and then more seed dissemination. There is really such an abundance of things to observe that there should be only minor duplication and no monotony, and what is done may be both fun and profitable in many ways. We will not repeat here things that may well be found in the average school outline. We will confine ourselves to observations about herbaceous plants and associated phenomena.

The plant cover most obvious to the average school is the lawn that covers much of the earth outside. This may be a veritable gold mine of things to be observed. The average lawn in fall is unevenly covered with vegetation. Why are some spots bare and others well covered with plants? Find a bare spot and make a simple map of the plants that are found along its borders. Are these plants alike and do they resemble plants found most abundantly a yard or so from the bare spot?

In all probability any school lawn will be rich in basal leaves or rosettes, some of which were emphasized elsewhere in this insert. The most likely forms would be dandelions, broad-leaved and narrow-leaved plantains. A few of these may be marked by simple markers in the fall before the snows come. Reports may then be made in the spring as to how many of them came through the winter successfully. If pegs bearing numbers are driven into the ground beside these rosettes, it may be determined whether the plants survived a few months, a few weeks, or a year or more. It is worthwhile knowing how these basal leaves and rosettes develop, too. A few marked plants may prove to be better teachers than many textbooks are. It might be well to select two or more rosettes—perhaps of dandelions—of equal size and apparent vigor. Try pulling off half the leaves of one plant and all the leaves of another. See if this does much to weaken the plant by spring or, if you wish, in a longer or shorter time. Then try cutting off the head of the plant just below the surface of the ground. Notice if the underground system grows a vigorous new rosette in a short time, or if it produces more than one such head, or if it is killed by the treatment it gets. Then try digging out the deeper roots to see if this does the job of elimination. What you learn by these activities you have learned by your own efforts, and what you find should be convincing evidence to you.

You might be interested in getting some information on the number of weeds that have substantial underground systems. You might see how many of these plants that have their aboveground portions killed by the winter come back vigorously in the spring, owing in part to the use of the food that may have been stored in those underground areas. Just select any half-dozen fall rosettes or basal leaf clusters, mark them and see how many produce vigorous plants in the spring. Not a few will leave a pattern of their fall leaf forms on the ground as decayed leaves, but will produce a healthy leaf structure in the center of this pattern. Evening primrose and dandelion do this spectacularly sometimes.

In late fall, grass fires may be frequent. Make some record of the plants whose tops get burned and yet whose underground portions go unscathed. It is often interesting to go along the border of some stream whose banks become flooded and notice how many times rosettes or basal leaves of weeds appear conspicuously under the water. Mark a dozen of these with sticks, and after the flood has passed—or the following spring—notice how many of these plants were killed by being flooded. Is what you observed true of all such leaf forms? Is the deciding factor the "rosette" or the kind of plant?

You may be interested in the effect of temperature on the seeds of plants. The weed tops of many common weeds behave variously in winter. Some may be bent over to the ground and covered with snow and trash relatively early. Some may stand erect through the winter. Others may stand erect even through a vicious grass fire. Collect some seeds from seed pods of these three categories and try to germinate them to see if the freezing, the roasting, or the protection they received made any difference. A simple way to test this germination in a day or so might be to sprinkle some paper toweling with the seeds, using a separate towel for the seeds of each category. Soak the toweling and put it away in a reasonably warm place where germination might be expected. Check each day to make sure the towels have not become thoroughly dried: this would interfere with the development of the seeds and seedlings. Do you find that any of the seeds that apparently had been wel roasted by a passing fire are still able to germinate? Does freezing kill one season's seed crop?

Extremes in temperature may affect other qualities in the herb cover of unwooded lands. Freezing may improve the flavor of a number of kinds of "greens," and of course, may affect their crispness. Some plants improve by such treatment; others deteriorate. If you are of a genuinely experimental nature you may wish to learn more about why animals select or reject weeds in pasture lands. Take a small piece of mullein leaf and touch it to your lips or tongue. Does it affect you mucous membrane in any way? Dry some of the leave and rub a little of the dried fuzz on the sensitive skin between your fingers. Does this affect the surface o your skin in any way? It may or it may not, but if i does you may understand one reason why these weed persist in pastures that are otherwise grazed clean.

Weed rosettes frequently provide safe retreats fo many insects that may, when times are better, feed on more valuable plants. You may not be able to make a careful study of this situation, but it might be fun to make a series of collections showing the kinds of insect that may be found on different kinds of rosettes or basa leaves in late fall, winter and spring.

Instead of trying to get much information about many kinds of basal leaves and rosettes, some of you may prefer to make more exhaustive studies of some one kind. I would suggest that ordinary oxeye daisy basa leaves might be most useful—and possibly surprising Taste the basal leaves at different stages of their maturity. At some times they are delicious, at other time rank, so it is not safe to say simply that they are edible or inedible. Any study such as this might make yo reserve judgment or even reverse former judgments and may be helpful in developing the scientist that is in al of us to some degree.

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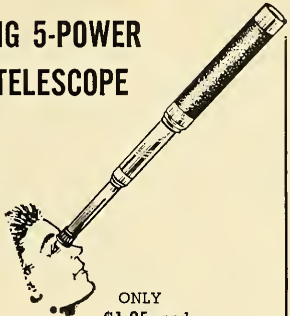

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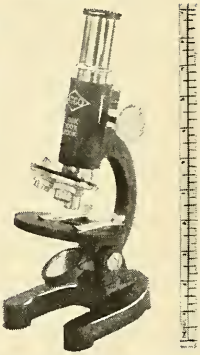

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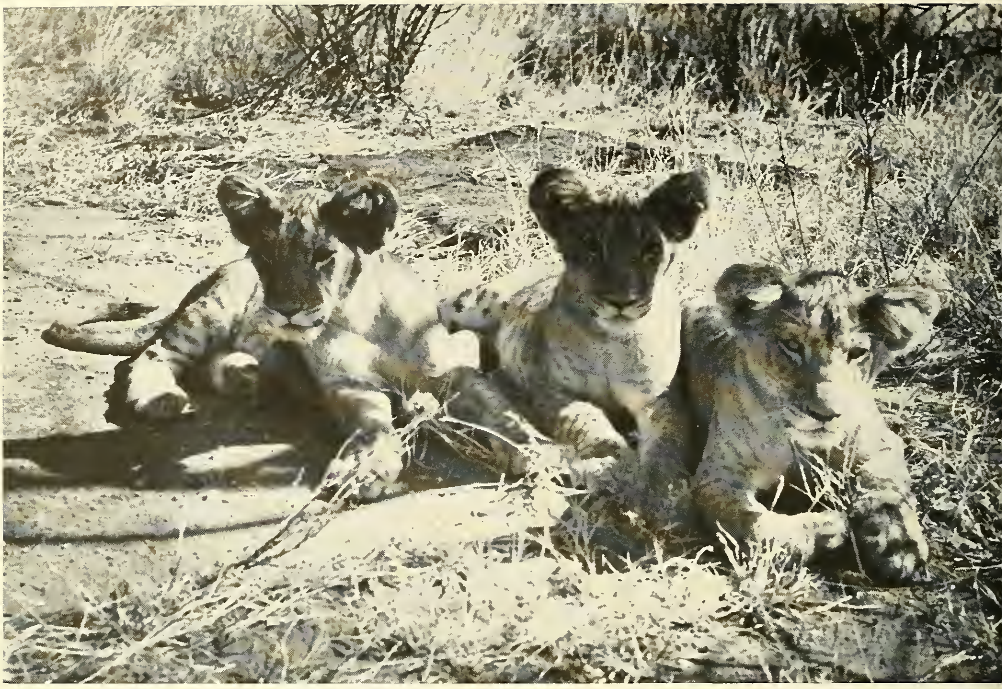


Fast-growing lions at six months: the trio of cubs—Elsa. Lustica. and the Big One—lounge in the sun near the Adamsons' home in Isiolo.

Elsa. Adamsons fe
would be easy to tra
not only for life
their home. but also as
traveling compani
on their frequent safar

LIONESS OF TWO WORLDS

After three years as a pet, Elsa was taught to survive freedor

Photographs by George and Joy Adamson

WHETHER FACT OR FICTION lies at the root of tales that credit the Assyrians with having trained lions. as cheetahs. greyhounds, or retrievers are today trained to hunt in co-operation with man, the Adamsons (George, a game warden, and his wife, Joy) can certainly claim to be the first for several thousand years to have made an approach to achieving that result with a lioness—and that. *not* by any deliberate attempt to do so, but merely by allowing the animal to grow up in their company and *never* permitting her nature to be subjected to the tensions of being confined in any manner.

The history of the lioness Elsa. reared from earliest fancy to three years old and finally returned to a wild li forms a unique and illuminating study in animal psych ogy—a subject to which the last half-century has seer wholly new approach. Partly. no doubt, in revolt agai the tendency of nineteen century writers to attrib to animals anthropomorph qualities of intelligence, ser ment, and emotion, the twer eth century has seen the velopment of a school thought according to wh the springs of animal havior are to be sought terms of "conditioned

ABOUT THESE PHOTOGRAPHS

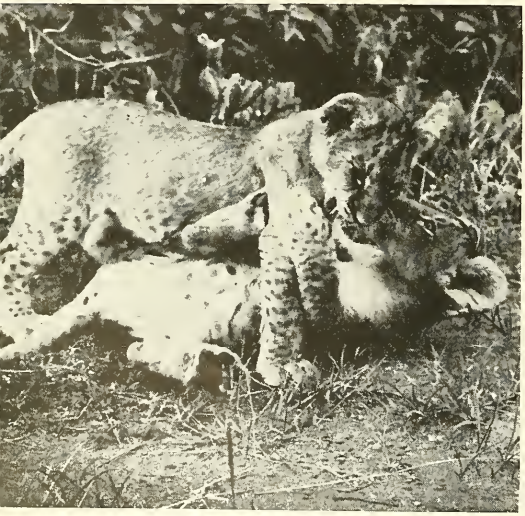
JOY ADAMSON's best seller, *Born Free* (Pantheon Books, Inc.), tells of her experience with a home-reared lioness. Presented here are the preface by LORD WILLIAM PERCY, noted British sportsman. and some of the unique pictures Mrs. Adamson and her husband. George. made during three years with Elsa. Mr. Adamson is Senior Game Warden in the Northern Frontier Province of Kenya. Selections from the book first appeared in *The Saturday Evening Post*.

flexes," "release mechanisms," and the rest of a wholly new vocabulary, which is regarded as the gateway to a clearer understanding of animal psychology. To another way of thinking, which cannot reconcile that mechanical conception with the diverse character, intelligence, and capabilities exhibited by different individuals of the same species, that gateway to understanding seems as far removed from truth as the anthropomorphism of a previous generation, and more apt to raise a further barrier to a sympathetic understanding of animal behavior than a revelation of it.

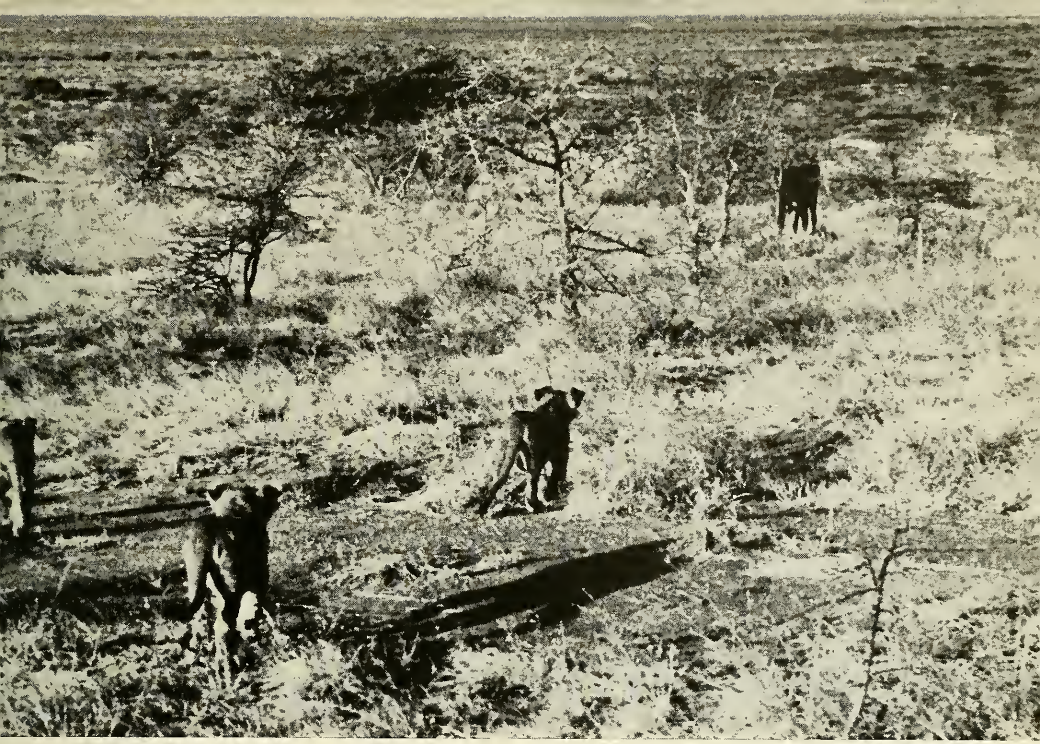
To whatever way of thinking the reader of Elsa's history may lean, it provides a record of absorbing interest depicting the gradual development of a controlled character that few would have credited as possible in the case of an animal as potentially dangerous as any in the world. That such a creature, when in a highly excited state with her blood up after a long struggle with a bull buffalo and while still on top of it, should have permitted a man to walk up to her and cut the dying beast's throat to satisfy his religious scruples and then lend her assistance in pulling the carcass out of a river, is an astonishing tribute no less to her intelligence than to her self-control.

If the most fanciful author of animal stories of the nineteenth century had drawn the imaginary character of a lioness acting in that manner, it would assuredly have been ridiculed as altogether "out of character" and too improbable to carry conviction—and yet Elsa's record shows that it is no more than sober fact.

If in her growth Elsa has made her own commentary both on the "anthropomorphism" of the nineteenth century and on the "science" of the twentieth, she has not lived in vain.



Romping, cubs test their growing strength on each other. One of favorite games was to dethrone a sister from top of potato sack.



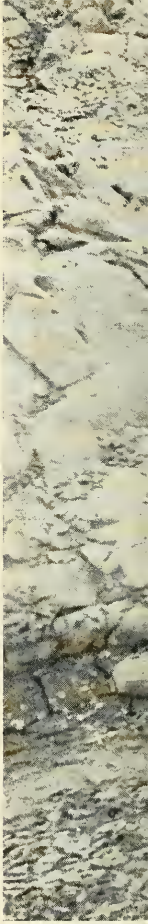
When cubs went into the bush, they often had adventures. Once, five donkeys approached dozing cubs, who woke up and charged together.

This first stampede delighted cubs so much, when Adamsons' forty donkeys and mules later came near house, the cubs, *left*, drove them off.

Wistfully gazing down road, Elsa sees sisters leave for Nairobi to fly to a zoo in Holland. It was impossible to raise three growing lions.

George Adamson gives a lesson in retrieving to Elsa. She was unafraid of sound of shot and she learned to associate blast with the dead bird.

affes amused Elsa,
l one day she glimpsed
y. She slowly
lked them. But she
med annoyed as
beasts ignored her.



Perched in limbs of
tree, Elsa rests, takin
breeze, during visit t
Lake Rudolf. While
lions rarely range fa
she took long treks w

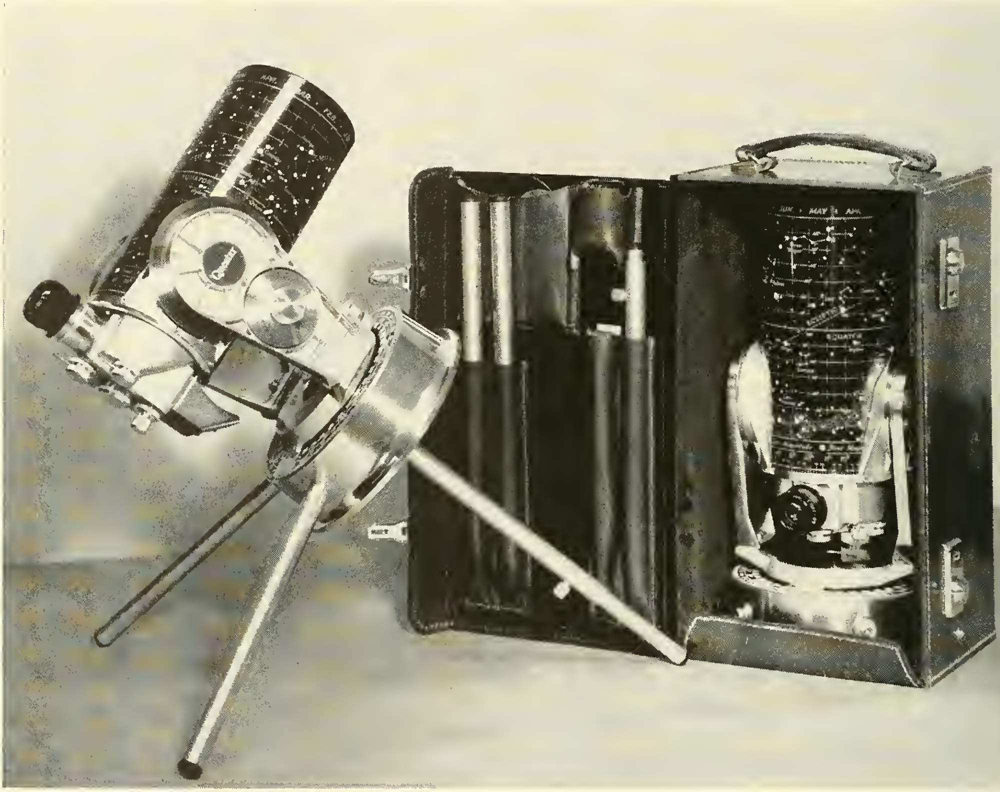
A long drink was a welcome treat for Elsa later in the Lake Rudolf trip as water holes were difficult to find.

Stretched on Land Rover's canvas top, Elsa is ready for a ride. She often seemed unwilling walk if car was near.

Trained for future return to the wild, Elsa killed a half-ton water buffalo. To help drag victim from the water, she tugged at tail.

Now living as a wi
lioness. Elsa is final
free. Yet she sti
recognizes the Adamson
who had given h
a life in two world

While playing the lead in the Broadway musical "Greenwillow," the distinguished American actor Mr. Anthon Perkins phoned us from New York. We learned that he had used telescopes since boyhood, has a 4-inch refracto and had practically memorized our booklet. He asked some questions and in June took delivery of a quartz-mirrore Questar. When asked how he liked it, he said, "Your booklet does not do it justice." We asked if we could quot him in this space. "Indeed yes," he replied, "but change that to read 'no catalogue could do it justice.'"



LAY THAT BURDEN DOWN

When you finally get tired of lifting and carrying your telescope in and out of doors, tired of setting it up and taking it down in chilly darkness —

When you've had enough of heavy loads, of quivering tubes and images, enough of drives that falter and slow-motions that fall short —

When you finally realize that it has become too much trouble to use your telescope any more because it only gives you an aching back and a pain in the neck — when you've had your fill of the whole unhandy contrivance — *send for the Questar booklet!*

The Questar booklet will tell you how to lay your burden down. No more lifting, no more toting, no more setting up of heavy, clumsy parts. Questar weighs but 7 pounds. It is always assembled, always ready to use.

It will tell you how Questar stands alone, the only thing of its kind, with the latest kind of optics, the mixed lens-mirror system of the new catadioptric optics. How Questar's folded focal length keeps it fabulously short, how so short a telescope can be as stiff and rigid as a great observatory instrument. It will tell you how Questar's images are as rock-steady as a microscope's, how its controls are ready to your fingertips, and how its 360° continuous slow-motions have a buttery smoothness with absolutely no backlash at all. It will tell you of finer performance than was ever dreamed of from only 89 mm. of aperture, and prove that point by the amazing resolution of the photographs it takes.

But hold on — let the booklet tell you this — let us use this space to tell you other things.

Let us speak, for instance, of investment value. Questar costs no more than ordinary 'scopes would if they were so well mounted as to be equally solid and vibration-free. But let's face it—Questar optics cost more by the extra hours of human labor required to make, for example, mirrors that must be 16 times more accurate of figure than the ordinary kind. Questar's mounting, too, has over 235 separate parts, each one of the best procurable alloys down to the last small stainless-steel screw.

So let us tell you what we have found ou — that Questars are so greatly in deman that the few which reach the second-han market depreciate an average of less tha 7% per year! Imagine this — telescope 3 years old may bring 80% of their purchase price! We know of few manufactured products with such amazingly higl value at resale.

Remember then, that if you too becom a Questar owner, you will be making th most conservative investment possible. W firmly believe that it will cost you less pe year to enjoy a Questar.

Questar, as illustrated, still costs onl $995 postpaid, in handmade velvet-line English leather case. Terms are available May we send you the booklet?

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SKY REPORTER

ürer's woodcuts of the sky

SIMONE DARO GOSSNER

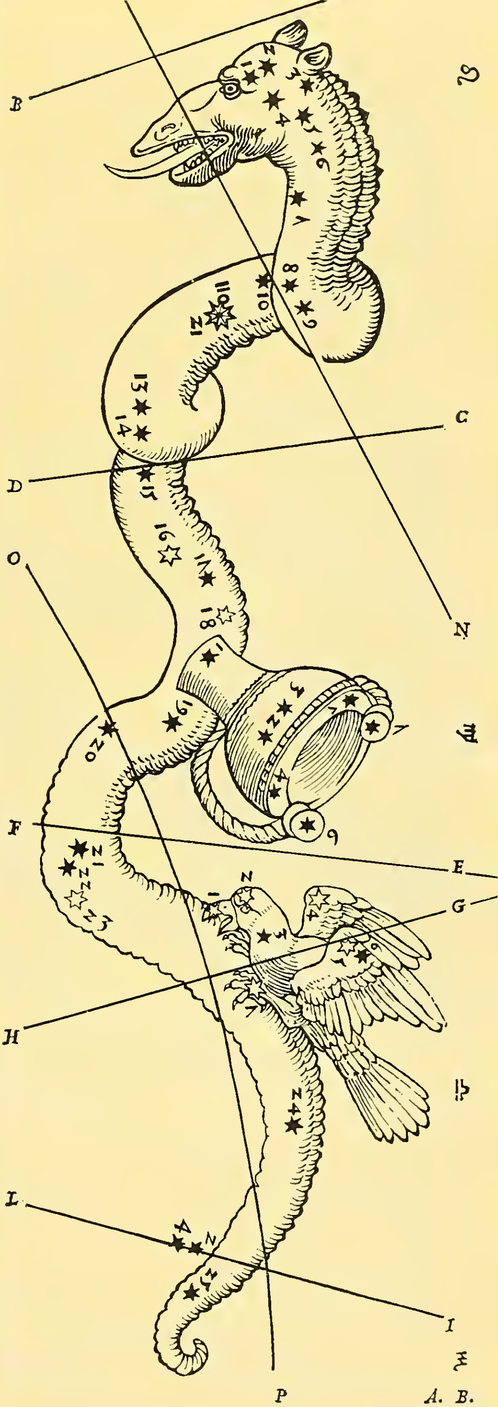
ROM EARLIEST TIMES, the principal function of constellations was to provide an easy way to refer to a ven area of the sky and to locate celestial objects. "The ar on Orion's knee" and similar expressions were in mmon astronomical use until the start of the seven- enth century. Thus, when corresponding mythological ures were drawn for scientific purposes, they had to nform to conventional attributes of the particular ani- al or demigod, so they might be recognized; but, most all, the subject had to be shown in the prescribed pose that individual stars might be identifiable. For exam- e. Orion would be depicted in hunter's garb according the artist's taste, but his leg would be bent always in e same way to accommodate the star on his knee.

Such restrictions were of little concern to illustrators classical literary works dealing with the mythology of nstellations. A case in point is the charming edition of yginus' *Poeticon Astronomicon* printed at Venice in 82 by Erhard Ratdolt. The anonymous artist—perhaps tdolt himself—who designed the woodcuts adorned the ures with a fanciful array of stars bearing no resemance whatever to the actual constellations.

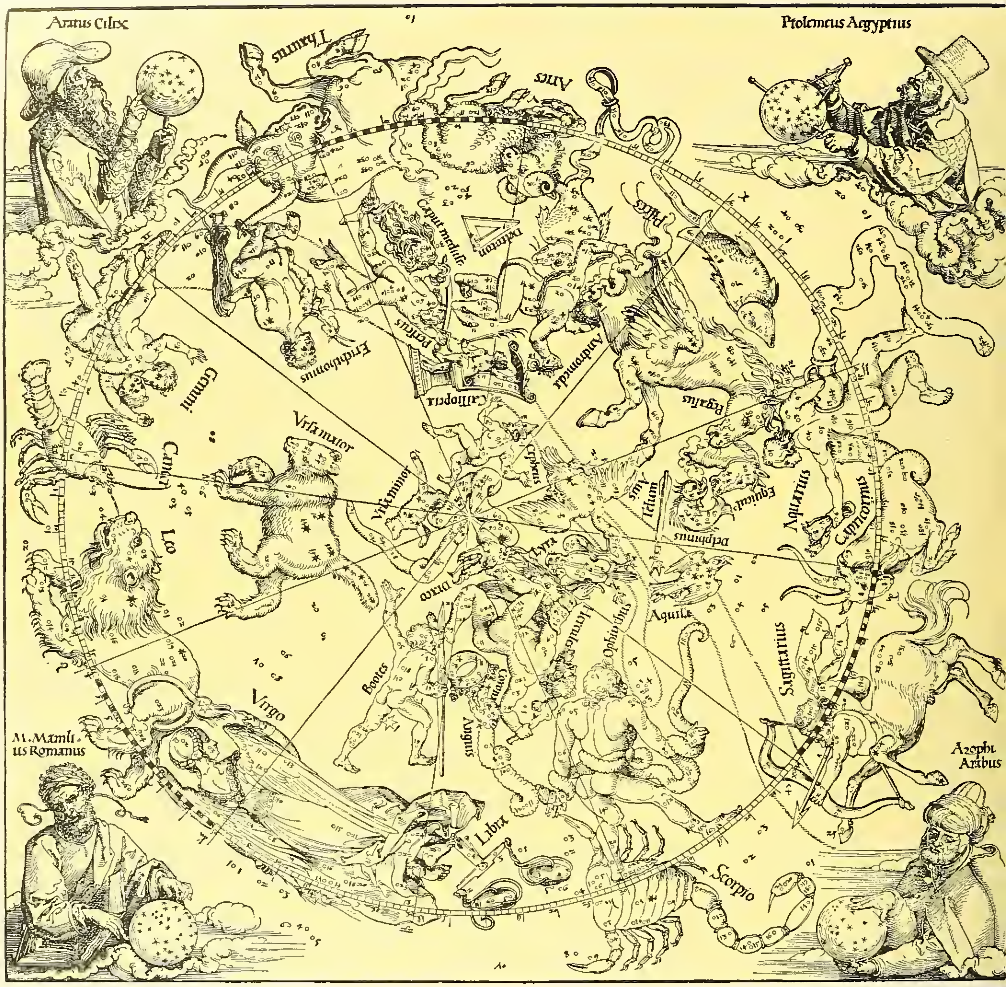
Offhand one would expect an artist to prefer the rela- ve freedom of this non-scientific approach; but, strangely ough, the most beautiful examples of astronomical illus- ations are celestial maps drawn for the specific purpose showing the exact positions of stars. All astronomers ow Bayer's *Uranometria* (1603) and Flamsteed's *Atlas elestis* (1729), both of which exist in several editions d are found in the libraries of major observatories. ked to name the oldest printed star map, they would obably mention the *Planisphere* of Apianus (1536) ich, although very rare, has been reissued in facsimile 927) and is mentioned occasionally in the astronomical erature. Yet, Apianus' map is a poor second, chronologi- lly and aesthetically, to woodcuts showing the Northern d Southern Hemispheres, which the great German master brecht Dürer (1471-1528), completed in 1515.

It is hard to explain why Dürer's maps have received little attention in astronomical circles. Perhaps it is cause they were issued separately rather than in a scien- ic book. Apianus' map, which was printed first as a oadside, might have fared just as poorly had it not been cluded in a later treatise of the same author.

The circumstances that led to the execution of Dürer's ps are not known in detail. According to the inset on the wer left corner of the southern map, they were planned Johannes Stabius, professor of astronomy at Vienna d part time resident of Nuremberg, and the stars were tted by the astronomer Conrad Heinfogel, also of remberg. Dürer, of course, drew the constellation fig- es and the ornamentation. A resident of Nuremberg



HYDRA CONSTELLATION design from 1569 edition of Aratus published in Cologne imitates Dürer's Hydra seen on p. 61.

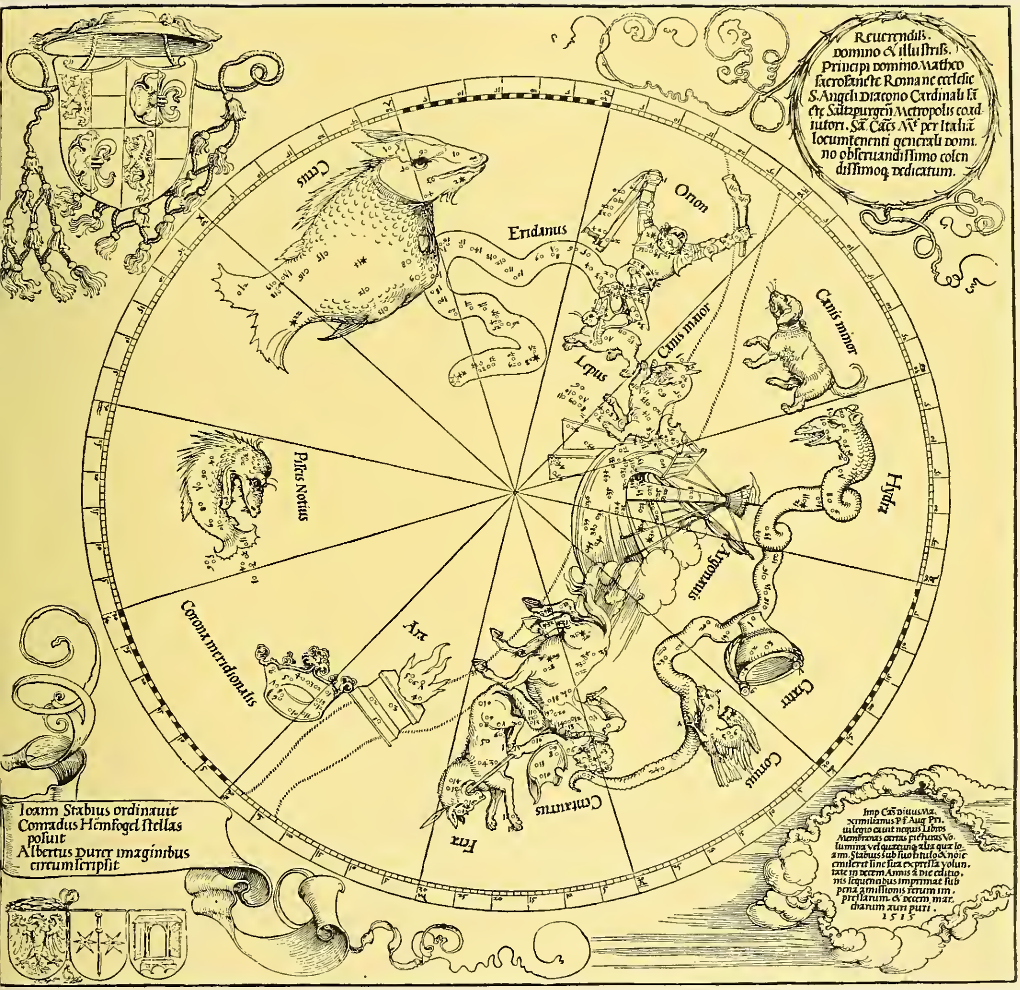

Aratus Cilix
Ptolemeus Aegyptius
M. Manlius Romanus
Azophi Arabus
Taurus
Aries
Pisces
Deltoton
Caput meduse
Perseus
Andromeda
Pegasus
Erichthonius
Cassiopea
Gemini
Cancer
Leo
Vrsa maior
Vrsa minor
Cepheus
Auis
Telum
Equiculus
Delphinus
Aquarius
Capricornus
Lyra
Draco
Aquila
Hercules
Ophiulcus
Serpens
Sagittarius
Bootes
Corona
Anguis
Virgo
Libra
Scorpio

Celestial map of Northern Hemisphere is rendered in a woodcut by Albrecht Dürer, dating from 1515. This map and its companion piece, *facing page*, are to be found in th Rosenwald Collection, National Gallery, Washington, D.

himself. Dürer counted among his friends many of the humanists of his time. There is little doubt that his participation in this undertaking resulted as much from his intimate association with these scholars, as it did from his considerable reputation as an artist.

Although Stabius is credited with planning the maps, historical evidence gives more importance to Heinfogel's role. Another set of maps, drawn on parchment, was discovered in Germany about twenty years ago. Dated 1503, they also originated in Nuremberg and bear Heinfogel's name along with names of two other scholars, Dietrich Ulsen and Sebastian Sperancius. Contemporary correspondence indicates that Heinfogel had secured accurate star positions a few years earlier; thus, presumably, he had plotted both the 1503 map and Dürer's. The cor stellation figures of this earlier set generally resemb those drawn by Dürer, but there is an unevenness in the quality that suggests more than one hand. Dürer may hav used them as a guide and perhaps completed a few hin self. In any case, the similarity of design is too great t leave any doubt that he had access to this set.

Discovery of the 1503 maps raises an interesting que tion about the circumstances that led Dürer to take pa in the Stabius-Heinfogel project. Heinfogel was a frien of the aging Nuremberg astronomer Bernard Walthe who had been patron and disciple of the great Regiomor tanus (1436-1476). The latter is known to have used manuscript map of the heavens in two hemispheres datin to the first half of the fifteenth century. The fate of th


Reuerendiss.
domino & illustriss.
Principi domino Mattheo
sacrosancte Romane ecclesie
S. Angeli Diacono Cardinali sa
cre Saltzpurgen Metropolis coad
iutori. Sac. Caes. Mt per Italia
locumtenenti generali domi.
no obseruandissimo colen
dissimoq. dedicatum.
Cetus
Eridanus
Orion
Canis maior
Canis minor
Lepus
Piscis Notius
Hydra
Argonauis
Corona meridionalis
Ara
Crater
Coruus
Centaurus
Fera
Ioann Stabius ordinauit
Conradus Heinfogel stellas
posuit
Albertus Durer imaginibus
circumscripsit
1515

SOUTHERN HEMISPHERE star map by Dürer bears inset in ower left corner that names Johannes Stabius as planner and Conrad Heinfogel as astronomer who plotted stars. The Hydra figure is more delicate than is the copy in Aratus.

map is unknown, but another of the same period, discovered at Vienna in 1933 and believed to be a copy, closely resembles the 1503 Heinfogel version. Be that as it may, t is most probable that Walther had seen Regiomontanus' map. since he was his closest associate. Besides, the inventory of Walther's estate includes a description of a celestial map which could be that of 1503 or an earlier—unknown—version of the same. Seen in this light, the fact hat Dürer bought his house from Walther takes on greater mportance: this mundane coincidence would have given Dürer a chance to see Walther's maps and to recognize heir artistic interest. Was it his own initiative or Walther's friendly persuasion that eventually led to the creation of he handsome woodcuts reproduced on these pages?

The influence of Dürer's work on subsequent star maps is difficult to assess. The many resemblances that are noted in Bayer and Flamsteed, among others, could be attributed to the fact that similar designs are found already in the Arabic manuscripts of Ptolemy, and the block books of the Renaissance. The problem is obscured further by the total lack of reference to Dürer even by the most callous imitators. A notorious example is the edition of Aratus' *Phainomena* published at Cologne in 1569 by one Theodor Graminaeus. The author, who gives himself full credit, illustrates each constellation separately (see picture of Hydra on p. 59), but uses in every case an almost exact copy of the appropriate Dürer design. However, it is not in such similarities that the influence of the German master must be sought, but in the new standards of elegance so apparent in celestial maps of the next century.

THE SKY IN NOVEMBER

From the Almanac:

Full Moon	November 3,	6:58 A.M., EST
Last Quarter	November 11,	8:48 A.M., EST
New Moon	November 18,	6:47 P.M., EST
First Quarter	November 25,	10:42 A.M., EST

For the visual observer:

Mercury will be in inferior conjunction on November 7 and will transit across the sun's disk on that date (see below). It will be in the morning sky for the rest of November. Favorably placed for observation during the last two weeks of this month, it will rise approximately one and a quarter hours before the sun on November 15. On November 24, it will reach its greatest western elongation and will rise one hour and three quarters before the sun. It should be visible low in the southeastern sky for several days before and after elongation.

Venus (−3.5 magnitude) will be very conspicuous in the evening sky. In the southwest at nightfall, it will set at about 6:45 P.M., local standard time, on November 1, 7:00 P.M. on November 15, and 7:15 P.M. on November 30.

Mars, in Gemini, will brighten steadily from −0.3 magnitude on November 1 to −0.9 on November 30. Although its nearest approach to the earth will not be reached until the following month, it will be only 62 million miles away at the end of November. It will rise at about 9:00 P.M. on November 1, 8:00 P.M. on November 15, and 7:00 P.M. on November 30. Several degrees south of the twins (Castor and Pollux), it will pass nearly overhead a few hours after midnight and will remain visible until sunrise.

Jupiter (−1.5 magnitude) will be found in Sagittarius, low in the southwestern sky after sunset. It will set at 8:00 P.M. on November 1, 7:15 P.M. on November 15, and 6:30 P.M. on November 30. Except for the first few days of December, this will be the last opportunity to observe the planet Jupiter until the latter part of February.

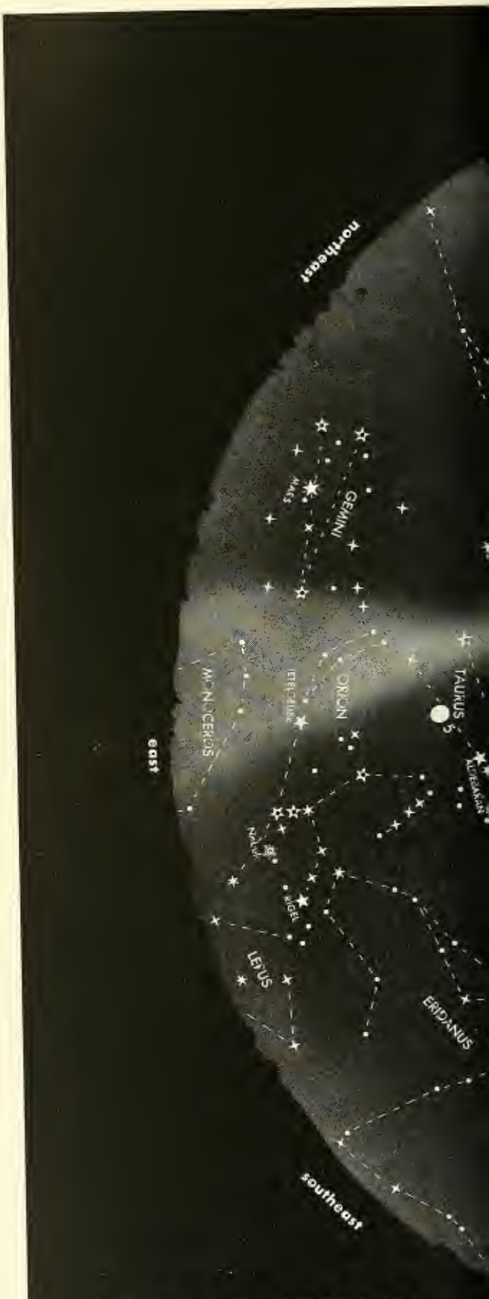
Saturn (+0.8 magnitude) will also be in Sagittarius, east of Jupiter. It will set at 9:00 P.M. on November 1, 8:00 P.M. on November 15, and 7:00 P.M. on November 30.

Interference by the full moon may reduce appreciably the number of Taurid meteors that will be seen during the first week of November. The Leonids, on November 16 to 17, should give a better display with an expected rate of fifteen meteors per hour (for a single observer).

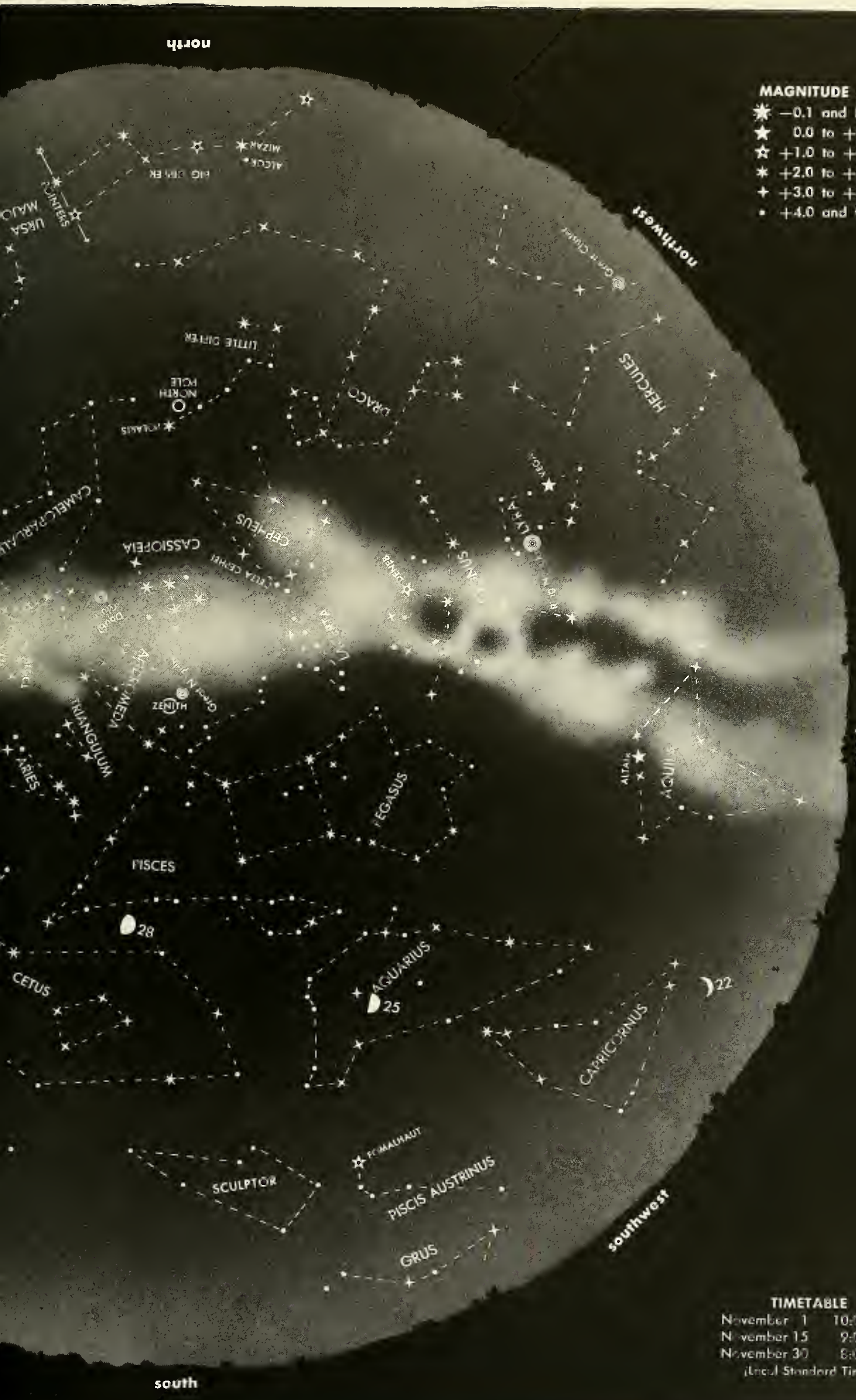
Transit of Mercury:

On November 7, Mercury will be seen passing across the lower portion of the sun's disk. This transit will be visible in North and South America (except the northwestern tip of Alaska), western Europe, Africa, New Zealand, and Antarctica. The time at which the phenomenon begins and ends will depend principally on the standard time zone of the observer. At New York City, the phenomenon will begin at 9:35 A.M., EST, and end at 2:12 P.M., EST. For other cities of the Western Hemisphere, it will be sufficient to allow for the difference between the local time zone and Eastern Standard Time. In Denver, for example, ingress will be at 7:35 A.M., MST and egress at 12:12 P.M., MST. In some areas of the West Coast and of the Pacific northwest, the transit of Mercury will be in progress at the time of sunrise.

MRS. GOSSNER, a Belgian-born astronomer who studied at Harvard, regularly prepares the SKY REPORTER column.



To use this map outdoors, hold it in such a way that the direction you wish to face is printed at the bottom. The constellations depicted below the point marked "zenith" are visible in that part of the sky at the time indicated.


north
URSA MAJO
POINTERS
BIG DIPPER
MIZAR
ALCOR
northwest
Great Cluster
LITTLE DIPPER
NORTH POLE
POLARIS
DRACO
HERCULES
CAMELOPARDAL
VEGA
LYRA
CEPHEUS
CASSIOPEIA
DELTA CEPHEI
DENEB
CYGNUS
Double Cluster
LACERTA
ANDROMEDA
Great Nebula
ZENITH
TRIANGULUM
ARIES
PEGASUS
ALTAIR
AQUILA
west
PISCES
28
CETUS
AQUARIUS
25
22
CAPRICORNUS
FOMALHAUT
SCULPTOR
PISCIS AUSTRINUS
southwest
GRUS
south

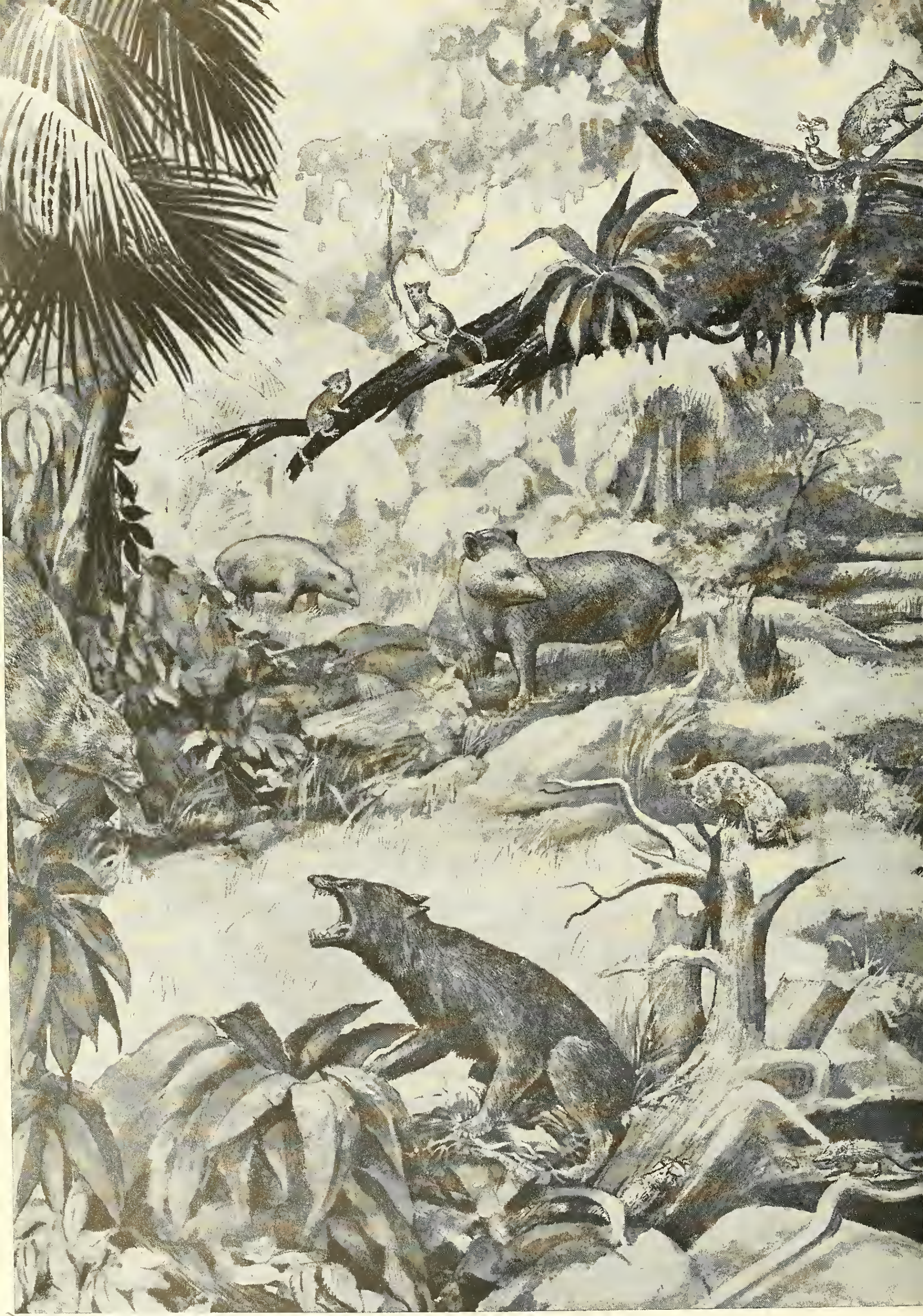
MAGNITUDE SCALE

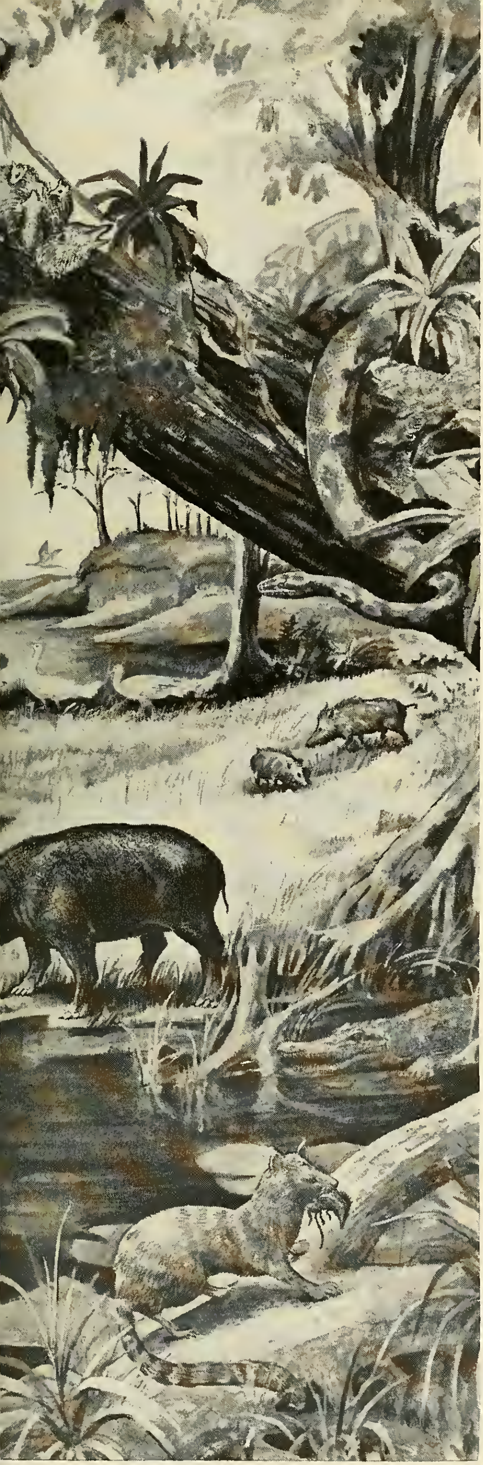
✸	−0.1 and brighter
★	0.0 to +0.9
☆	+1.0 to +1.9
✶	+2.0 to +2.9
✦	+3.0 to +3.9
•	+4.0 and fainter

TIMETABLE

November 1	10:00 P.M.
November 15	9:00 P.M.
November 30	8:00 P.M.

(Local Standard Time)





Part II

Fossil Bonanza

Geisel Valley lignite is rich in fossil vertebrate animals

By Georg Zappler

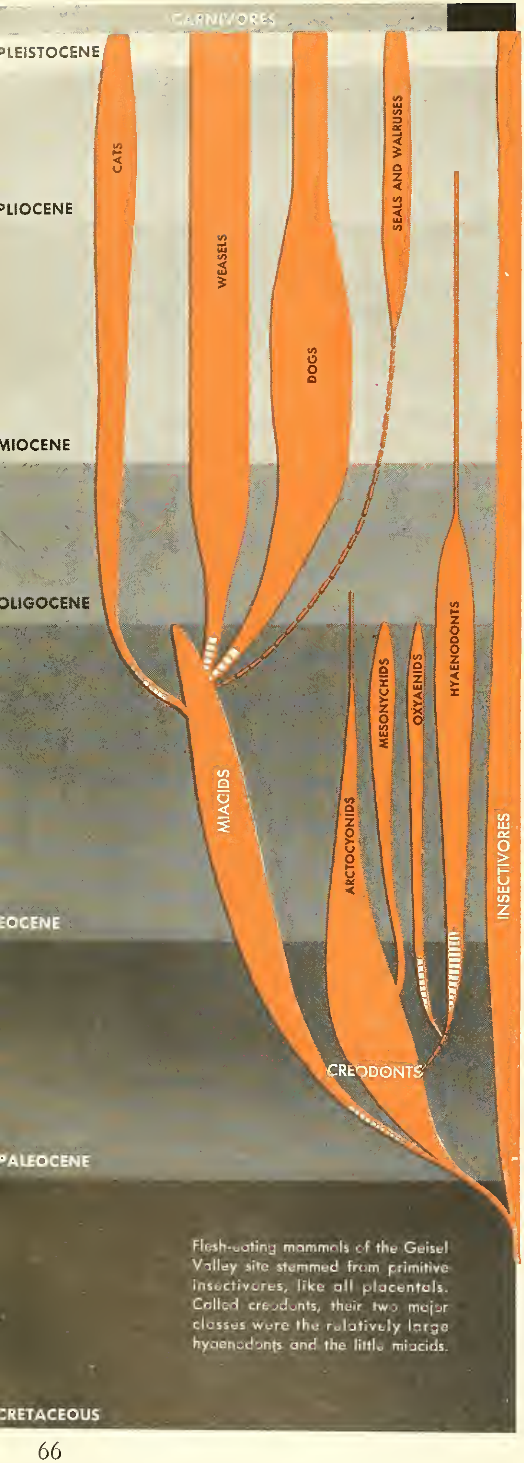
The wealth of invertebrate and lower vertebrate fossil material from the middle Eocene lignite beds of the Geisel Valley has already been described (Natural History, October, 1960). We have seen the niches each family occupied in the over-all economy of animal life and the changes each underwent as it spread to new geographical regions. But to round out any picture of these times, a survey of the mammals and birds is necessary.

Descended from mammal-like reptiles of the early Mesozoic, the mammals of today fall into two main categories, marsupial and placental, both of which were independently derived from a common, primitive, mid-Mesozoic mammalian stock, the pantotheres. The egg of reptiles—completely "terrestrial" and providing an artificial aquarium stocked with food (the yolk) for the developing embryo—permitted complete independence from an aquatic environment for the first time in vertebrate life. Now, this land-adapted germinal unit became, in mammals, modified for retention within the mother's body.

The degree to which the change from an egg-laying to a live-bearing mode of reproduction occurred is different, however, in the two lines of descent represented by the marsupial and the placental mammals. Among the former, the fertilized, shell-less eggs, retained in the body, contain some yolk and the embryos derive a small amount of additional nourishment from the mother's blood for a very limited period. They are then born alive—as tiny, larval young. These immediately crawl into a special pouch, the marsupium, where they attach themselves to the mother's milk glands located within, remaining there for several weeks. Only after this period of residence in an "external incubator" are the young capable of any independence.

The other mammalian lineage, the placentals, have gone still another step beyond the reptilian level in their reproductive modifications. With them, the young are born in a

Middle eocene land fauna from the Geisel Valley includes opossums and lemurs in the tree, primitive insectivores and carnivores in foreground—an early horse and tapirs behind them. Ground-dwelling bustards and cranes are seen at rear.



Flesh-eating mammals of the Geisel Valley site stemmed from primitive insectivores, like all placentals. Called creodonts, their two major classes were the relatively large hyaenodonts and the little miacids.

comparatively advanced stage of development. The place ta—the structure that enables the embryo to derive nou ishment from the mother's blood during this extend period of retention—is developed to a much greater gree than among the marsupials, the egg being almo yolkless. Placentals have no pouch, and their milk glan are exposed on the surface of the skin. However, bo marsupial and placental mammals are characterized live birth and by the possession of skin glands that ha become specialized for their offspring.

FROM the last period of the Mesozoic onward, find fossil remains of both marsupials and placenta At present, the former are a dying group, with only t opossums—now confined to North and South Americ seemingly well able to withstand placental competition. the beginning of Cenozoic times, opossum-like forms we cosmopolitan in their distribution, having reached all t major land masses before the close of the Mesozoic. Ho ever, only in the isolated situations provided by Sou America, during most of the Cenozoic, and by Austral since the close of the Mesozoic, were the marsupials al to undergo any great degree of adaptive radiation. Wi the re-emergence of the Panama isthmus, permitting southward surge of North American placentals (NATUR HISTORY, October, 1959), and with the coming of m and his introduced placentals to Australia, the fate of t previously successful, but now "inadequate" marsupi became sealed. South America has already witnessed t disappearance of most of its native pouched animals a the extinction of the varied marsupials of the Australi region seems but a matter of time. It is, at any rate, r strange to find a middle Eocene opossum among th Geisel Valley mammals that represent the first, but now "antiquated," post-Mesozoic radiation.

The insectivore finds can also be put under the headi of "archaic" in the general evolutionary scheme. Howev the specimens from the Geisel deposits were already sp cialized beyond the level of the primitive and generaliz insectivores of the late Mesozoic that provided the ba stock from which all the orders of placental mammals a derived. One specimen, a fairly complete skeleton, was th of a small animal about four inches long including the t and, to judge from the construction of its arms and leg particularly the grasping, unclawed hands—arboreal.

Today's insectivores include the ubiquitous shrews a moles, tenrecs from western Africa and Madagascar, t solenodonts of the West Indies, and the now strictly O World hedgehogs. The Geisel Valley forms do not appe to be directly related to any surviving insectivores, but th are closely linked to equally "aberrant" types dati from the same epoch and found as fossils in other parts Europe and in North America.

CONSIDERING their aerial habits, it is remarkable h well represented the bats are in the Geisel Valley c lection: there are numerous skeletal remains, sometin with preserved fragments of wing membrane, muscle, c tilage, and hair. The fossil history of bats is a very thin o Descended from a primitive insectivore stock, their m obvious specialization involves elongated fingers of th forelimbs, to afford support to a flight membrane stretch between. The Geisel Valley bats, together with contem raneous but not closely related finds from other parts

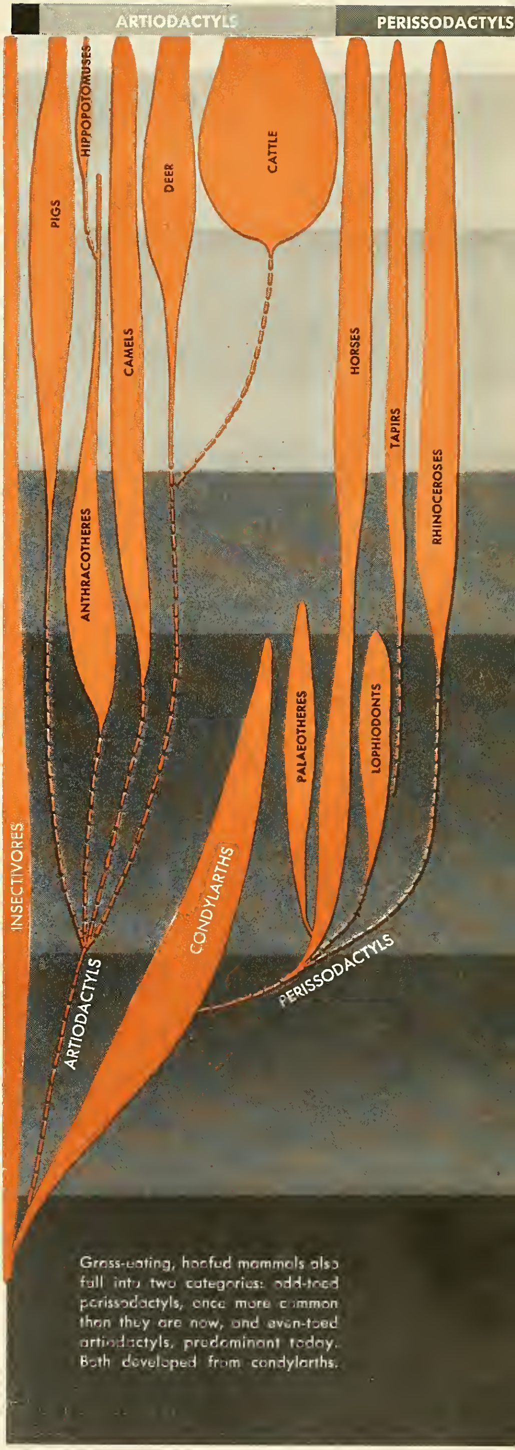
Europe and North America, mark the first appearance of these, the only flying mammals in the fossil record. Unfortunately, the relationships of Eocene bats to living genera are not at all clear. Still, it seems that these fossil forms belong to the generally small-bodied, insectivorous assemblage rather than to the fruit-eating group. Whereas the former, if mainly tropical, are cosmopolitan and attain even the remotest land areas, the larger fruit bats and flying "foxes" have never reached the Western Hemisphere.

By the middle Eocene, rodents had already been gnawing their way for some time toward the tremendously successful way of life that has made their modern descendants the most varied and populous order among all mammals. The Geisel Valley fauna included—on the basis of identifiable isolated teeth—several members of the primitive family that is believed to have provided the ancestors of all the various rodent lineages. By this time, the stock had already yielded the sewellels (the mountain beaver of northwestern North America is a modern survivor), primitive pocket gophers, and forms related to the kangaroo rats of our southwestern deserts. True squirrels, beavers, mice and their allies, and the porcupine group (including the South American pikas, chinchillas, and cavies) appear to be a later development. Ancestral rodents were globally distributed in early Cenozoic times, except for Australia and possibly South America, which they are thought to have colonized later by "rafting" across the Caribbean.

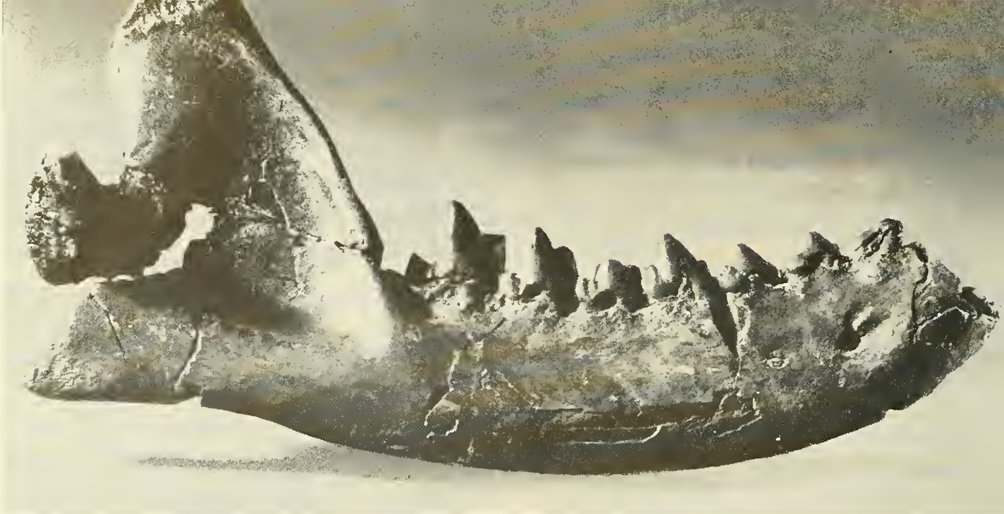
WHILE we are still dealing with the "archaic" mammals, it is fitting that the primate discoveries of the Geisel Valley excavations should be mentioned. Apparently, the early Cenozoic saw a tremendous radiation of stem primates—an order that now includes lemurs, tarsiers, monkeys, apes, and men. Very closely related to the protoinsectivores, these creatures, which resembled tree shrews, gave rise not only to the ancestors of the modern lemurs and tarsiers but also to many side branches, now extinct, included in those groups. In addition, this initial primate radiation presumably produced the direct ancestors of the monkeys—unfortunately not yet found as fossils—and the more recent stock that, in middle-to-late Cenozoic times, diverged to yield modern apes and man.

The Geisel Valley finds—small forms measuring about two inches excluding the long tail—included several lemurs and tarsiers belonging to genera that were common to other parts of Europe and had close relatives in Asia and North America at this time. The last-mentioned continent apparently ceased to play a part in the evolution of the primates soon after the close of the Eocene, there being no later record of any members of their order, and future developments leading to the higher primates probably took place in the Old World, for it is there that we find fossil monkeys, apes, ape men, and early men. Lemurs and tarsiers, as such, disappear from the fossil record after the Eocene, not showing up again until Pleistocene times. Today, there is a haven for lemurs in Madagascar (which they probably reached in the early Cenozoic) and their relatives, the lorises and pottos, are spottily distributed throughout tropical Africa and southeastern Asia, including Java and Borneo. Tarsiers are presently restricted to a single genus, living in the East Indies and the Philippines.

Thus far, in our review of the Geisel Valley bonanza, we have dealt in the main with lightly constructed members of the animal kingdom—organisms that seldom



Grass-eating, hoofed mammals also fall into two categories: odd-toed perissodactyls, once more common than they are now, and even-toed artiodactyls, predominant today. Both developed from condylarths.



Jawbone of hyaenodont is seen above. Hyaenodonts were among the largest of primitive carnivores and preyed on the herbivorous hoofed mammals; they survived into the midd Cenozoic. Note sharp cheek teeth for cutting and shearin

leave fossil clues to their past evolution and distribution and that are, therefore, of exceptional value wherever they are discovered. The relative frequency of such types of fossils from the Geisel Valley is one thing that makes this locality such an interesting one; but the lignite beds' yield of more solidly built mammals, although neither particularly frequent nor particularly unusual when compared with such fossils from other discovery sites of the same epoch, also deserves mention.

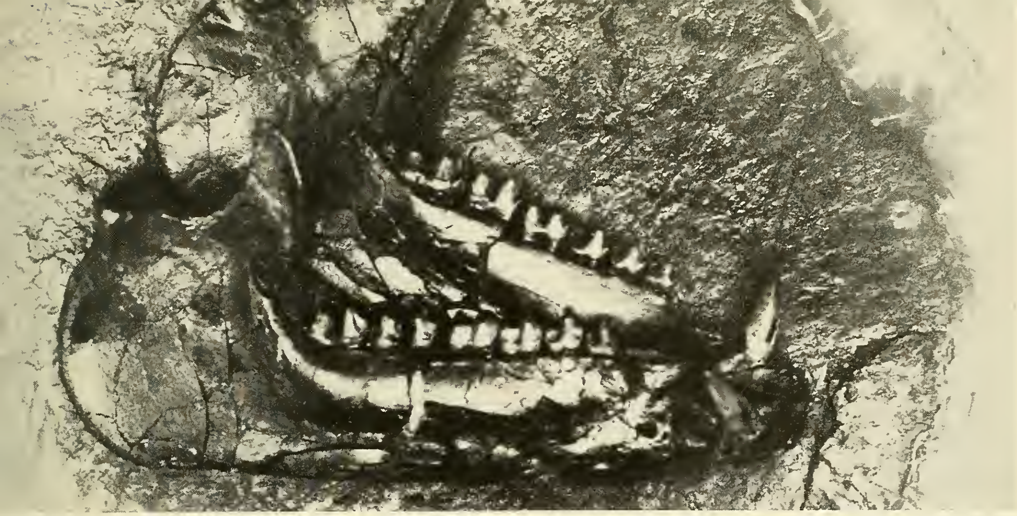
Bat skeleton, among first bat fossils to be found, still has traces of flight membrane between its elongated fingers.

Here, the mixture of "old" and "new" becomes strikin Although the carnivores among the Geisel Valley finds b long to archaic types, the herbivorous ungulates are a members of the two major modern orders of hoofed mar mals—the perissodactyls and the artiodactyls. The form —which now includes only horses, tapirs, and rhinos b was once much more diversified—are often referred to a the "odd-toed" ungulates, for in all of them the weigh bearing axis of the foot passes through the middle to with a concomitant trend toward elimination of the si toes in the course of their evolutionary history.

The artiodactyls, or "even-toed" ungulates—comprisir swine, hippos, camels, deer, antelopes, cattle, and all the relatives—have become, since the latter part of the Cen zoic, the dominant group of hoofed mammals, successful replacing many of the odd-toed perissodactyls as the latt have declined. The even-toed order is characterized b having the axis of the foot pass between the third an fourth digits, which may be the only ones, or which ma be flanked by two others beside.

All these limb modifications, particularly the degre of toe reduction, can be related to ecological "needs Depending on whether a forested, swampy terrain or th open grassland was the particular habitat to which th various groups became adapted, limb structures favorin locomotion over one or the other type of ground woul tend to evolve. Generally speaking, the forest dwellers r tained padded feet with several small hoofs, while th gallopers of the plains developed elongated, spring limbs terminating in large hoofs formed by the tips of th central toes—the third digit in the perissodactyls, the thi and fourth in the artiodactyls.

Now the beginning of the Eocene is marked by th sudden appearance of both these orders in Eurasia and i North America. Both are believed to have evolved ind pendently of each other from a generalized stock of ster ungulates called condylarths, which in turn derived fro



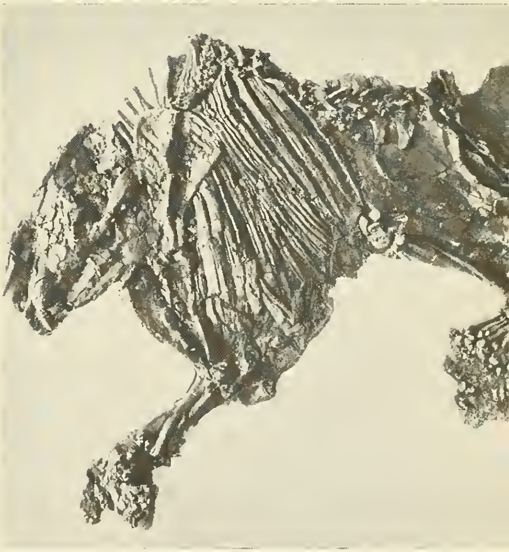
Embedded in lignite, this jaw of a herbivorous lophiodont has flat cheek teeth used in grinding. One of the "odd-toed" ungulates, or hoofed mammals, the lophiodont resembled modern tapirs, standing about eight feet long, three feet high.

ancient insectivores. The perissodactyls were represented by numerous lineages from the very beginning of their appearance in the fossil record; by middle Eocene times, they had become highly diversified. The artiodactyls, on the other hand, appear to have been less common at the beginning, not really becoming numerous until the latter half of the Eocene. But by then, they, too, were quite varied.

In contrast to most of the families of the various orders discussed previously—whose distribution indicates extensive interchange between North America and Europe via Asia—the middle Eocene families of both artiodactyls and perissodactyls were somewhat more restricted to one or the other continent. This has led many paleontologists o postulate a temporary submergence of the Bering connection (the situation that exists now) at about that time. The postulate is reasonable: a break of this nature would end to produce greater differences among the rapidly evolving ungulates on two separated land masses than it would within the "archaic" groups, which were already more stabilized. The zoogeographical dichotomy among he families of hoofed mammals was partially evened-out later when the land bridge between North America and Asia reappeared toward the close of the Eocene.

The Geisel Valley ungulates illustrate these marked, middle Eocene differences very well. Among the oddoed herbivores, we find numerous lophiodonts, a group of primitive animals resembling tapirs (but without proboscises), about eight feet long and three feet high. They were apparently restricted to Europe and Asia, but had contemporaneous perissodactyl relatives in North Amerca. True tapirs, which appear to have always been forest dwellers browsing on relatively soft vegetation, are descended from one or the other group among these early orms, which, in later Cenozoic times, were widely disributed in both the Old and New Worlds. They disappeared from northern continental regions quite recently and are now restricted to southeastern Asia (the Malayan region), and Central and South America, a continent they penetrated toward the end of the Cenozoic after the reemergence of the Panama isthmus.

A more familiar group of odd-toes, the horses, also show a striking zoogeographical separation between the Western and Eastern Hemispheres. The first true horses had, by middle Eocene times, become restricted to North America —the greater part of horse evolution then taking place on this continent. But a side branch, closely related to them



Skeleton of paleothere—an ungulate related to ancestor of modern horse—was among best preserved of Geisel finds.

Mr. Zappler here concludes his study of the Geisel Valley finds. Author and editors wish to thank the authorities of the Geisel Valley Museum, whose kind help in providing the pictures was essential in the preparation of this article.

at the outset, developed into the paleotheres of the Old World. Several of these were found preserved in the Geisel Valley lignite beds. One specimen in particular was remarkable for its completeness—a relatively small animal, under three feet long and about one and one-half feet high. However, to judge from other localities, most paleotheres were large, bulky creatures almost the size of modern rhinos. The paleotheres survived only into the beginning of the next epoch and all future Eurasian—as well as African and South American — horses derived from stocks originally developed in North America. That continent saw the extinction of its endemic horses a few thousand years ago (the South American equids had already died out) and it was not until the coming of the mounted Spanish conquistadores that horses were re-introduced.

Among the even-toes, the Geisel Valley fossils include representatives of some of the distinctively European groups characteristic of the middle Eocene. There were several small anthracotheres — primitive piglike animals with four-toed feet—which are thought to contain the ancestral population that, toward the end of the Cenozoic, gave rise to the hippopotamuses. For the Eocene, anthracotheres have been found only in European and Asiatic deposits but they invaded North America some time during the next epoch, to become extinct in this region soon after. Anthracotheres themselves died out during the Pleistocene and the hippos that stem from them, formerly widely distributed in Eurasia as well as Africa, now survive only in the aquatic habitats provided by the latter continent.

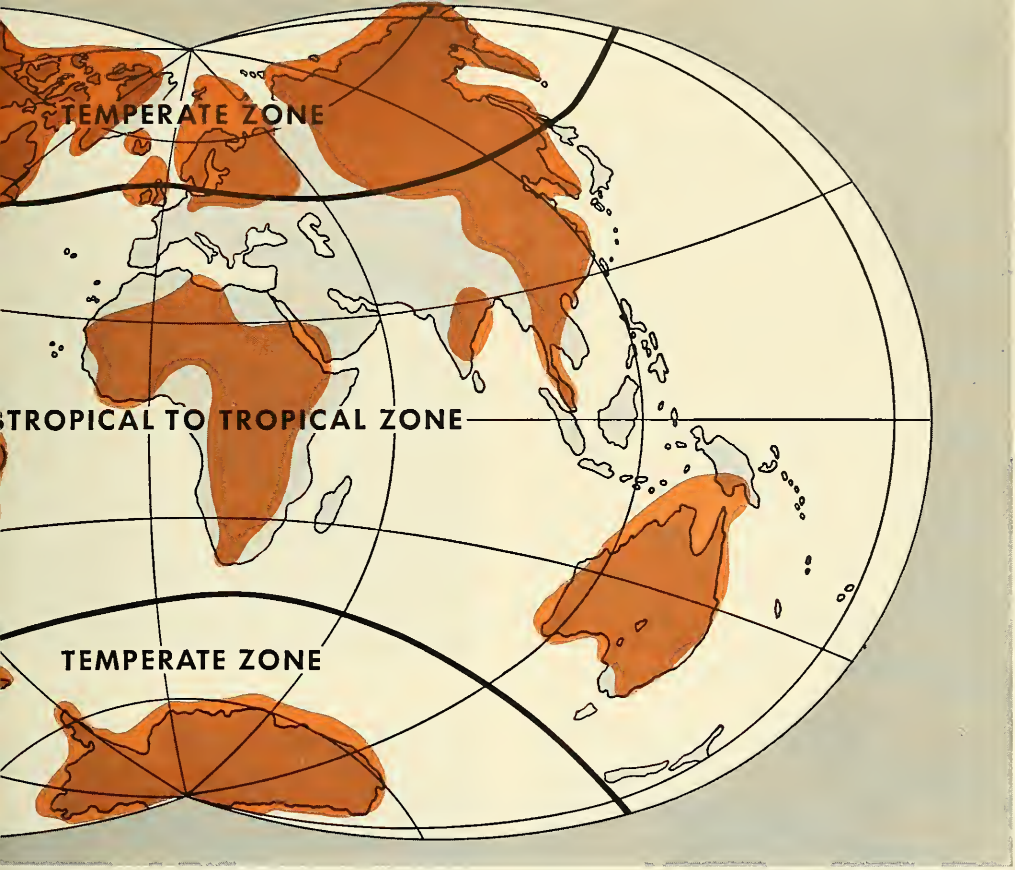
What about the "archaic" carnivores that preyed on these relatively modern, herbivorous ungulates? The Geisel Valley has yielded a number of these, typical of their time. They were creodonts, stem carnivores, among which one group—the miacids—gave rise to our modern carnivores. The creodonts date from the earliest Cenozoic and are derived, like all placentals, from primitive insectivores. They were highly successful until the end of the Eocene, when they were replaced by modern carnivores: the dogs and cats—to speak broadly—including bears, raccoons, and weasels under "dogs"; civets and hyenas under "cats."

The creodonts evolved along several lines, distinguishable by differences in the appearance and arrangement of their teeth. All of them developed some sharp cheek teeth for cutting and shearing, instead of the uniformly squared-off "grinding mills" of the herbivores: but the exact type of modification and the particular jaw position of the molars varied from lineage to lineage. In over-all appearance and diversification, however, these groups paralleled one another fairly closely with small, medium-sized, and large animals occurring in each line—all of them showing extensive interchange between Eurasia and North America from the very beginning of their history. (Isolated South America developed its own peculiar beasts of prey—marsupial "wolves" and "cats" instead of placental carnivores). The middle Eocene does not seem to demonstrate any particularly marked zoogeographical differences among creodonts and this can be explained by the fact that previous migrations had already established highly diversified but similar stocks on both continents. Thus, a break

World in the early cenozoic, as shown in this map, w
much warmer than it is today, with tropical or subtropic

in Bering Bridge, which was "mended" soon after, woul
not have the same evolutionary effect on the creodonts
in the case of the more recent ungulates.

The Geisel Valley creodonts belonged to two familie
One of them was represented by relatively large carnivor
called hyaenodonts, well able to tackle the ungulates
the time. The others were miacids. These were small an
weasel-like in appearance: forest dwellers of somewh
arboreal tendencies, they presumably preyed on conten
porary rodents. They were "progressive" in dentition an
also in their relatively large brains, setting the evol
tionary trend for later carnivores in those two feature
Whereas they themselves, as well as most of the othe
creodonts, became extinct at the end of the Eocene, th
first family referred to—the hyaenodonts—continued
into mid-Cenozoic times both in North America and Eu
asia, apparently well-enough adapted as beasts of prey
compete successfully with the descendants of the miacid
The complexity of diversification and dispersal routes
these, the modern carnivores, preclude our presenting an
coherent picture in a brief discussion of this kind. Excep
for Australia (at least until the arrival of man), the



imates ranging relatively far north. Europe was broken up nto a few segments. South America and Australia were both isolated, due to submergence of Panama isthmus and Pacific islands, and this resulted in unique fauna of those regions.

ave spread through all the available land areas, their suc-essful distribution being closely tied to that of the hoofed erbivores, rodents, and hares they prey on.

A brief word may now be said about the birds. By early Cenozoic times, birds—originally descended from the me reptile group that spawned dinosaur and crocodilian -had become fully "modernized." The toothed birds of e middle and late Mesozoic had become extinct, and a ajority of today's orders and families apparently were existence. The Geisel Valley offers evidence on this point.

Bird remains, although relatively rare, do exist. In some stances, scraps of skin with attached feathers were pre-rved together with isolated but identifiable bony parts. relative of the condors—now to be found only in the ew World—appears to have soared aloft over Germany uring the middle Eocene. Fragments of heron-like and wl-like forms, some fairly good specimens of primitive ranes and what has been tentatively identified as a horn-ill somehow managed to be preserved in the lignite beds. ranes are cosmopolitan today, but the hornbills occur nly in the tropics of Africa, Asia, and Australia.

One almost complete bird skeleton has been identified as one of the bustards, ground-dwelling birds — apparently confined to the Old World — which occupy the grasslands of Europe, Asia, and Africa. This is the earliest known bustard record. The bird in question had even better developed legs for running than do recent forms. Interestingly enough, its wing skeleton shows a mended break, perhaps due to the sort of courtship battle characteristic of present-day male bustards — violent wing-flapping and wing-beating constituting their main fighting method.

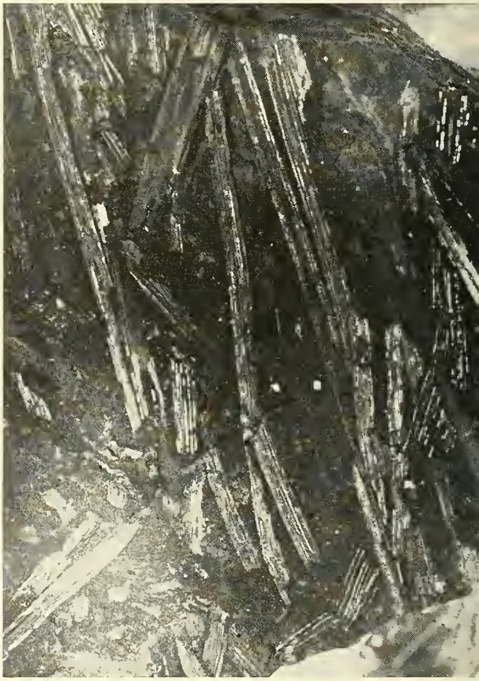
From this inventory, it is certainly possible to get a feeling for the diversity of life that, during a given "moment" of time, occupied the particular part of middle Germany where the Geisel Valley lies today. Actually, from the rates of deposition of the various layers of lignite, we can calculate that these strata cover a span between 200,000 to 400,000 years. Fossils are restricted mainly to the middle layers of this vertical "column," although fossil insects are more widely dispersed. Even so, the fauna was not strictly contemporaneous. This situation usually holds true for any fossil deposit, but if we bear in mind the relative stability of natural patterns, whose gradual establishment and further change involve years measured in the millions (at least, before the active interference of man) we can still think of all these animals as living together in a single ecological community.

What were the various situations available? A general habitat picture was given in Part I of this article (Natural History, October, 1960), one that appears based on good evidence. Also, if we accept the premise that close relatives of today's animals would tend to lead the same type of existence as do their descendants—such an assumption being corroborated by the presence of anatomical features evolved for a particular way of life, whether for climbing, running, or swimming—then the Geisel Valley community of the middle Eocene was one typical of the warmer, forested parts of the world today. It is true that, since animal lineages are known to have extended into different climatic zones than those occupied by their ancestors, evidence based wholly on invertebrate or vertebrate remains is somewhat doubtful. But if the whole community—and particularly the vegetation concerned, plants being much more "conservative" than animals—adds up to yield a framework into which all the component parts can be fitted without contradiction, we can assume to have deduced a past environment correctly.

As has been true from the beginning of life, the primary users of the sun's energy—the plants—passed on their self-manufactured carbohydrates and proteins to the animals that fed on them; these, in turn, providing nourishment for their predators. Organic decay, through the action of bac-

Preserved fruit from Geisel Valley brown coal deposit is shown magnified twenty times in these photographs. Th

Pine cone seen here was remarkably well preserved and has come down to us entire. Reproduction is almost natural size.

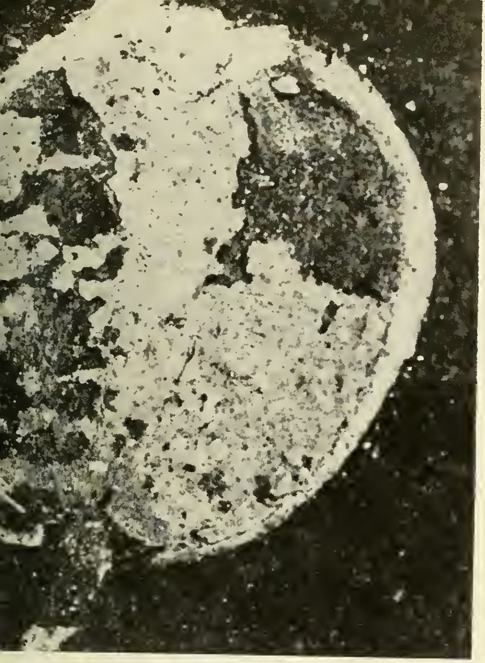


Needles from a pine tree are shown above. Pines grew i clumps on savanna that bordered more swampy river valley teria, completed the cycle of life and death, returning necessary elements to the soil and the atmosphere.

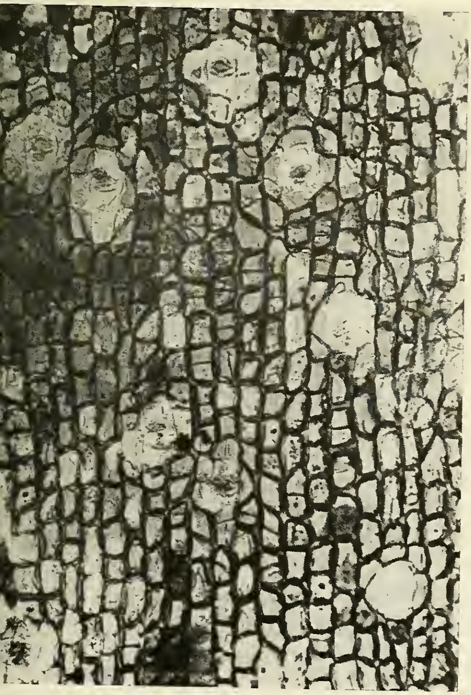
Although the roles have been fixed from life's origins, the players and their costumes change through time. The company we have studied here "played" middle Germany about forty million years ago. The scenery was a liana-hung, subtropical forest enclosing many shallow lakes and a few deep water holes. Swamplands overgrown with rushes merged in from the right and, in the background, the tall grasses of an adjacent savanna were occasionally topped by clumps of trees growing near streams.

Although the climate was warm enough to produce an essentially tropical flora, rainfall was seasonal. Thus, the over-all environment might best be compared to the monsoon forests of southeastern Asia today, where periods of drought will alternate with conditions that are characteristic of tropical rain forests the year round.

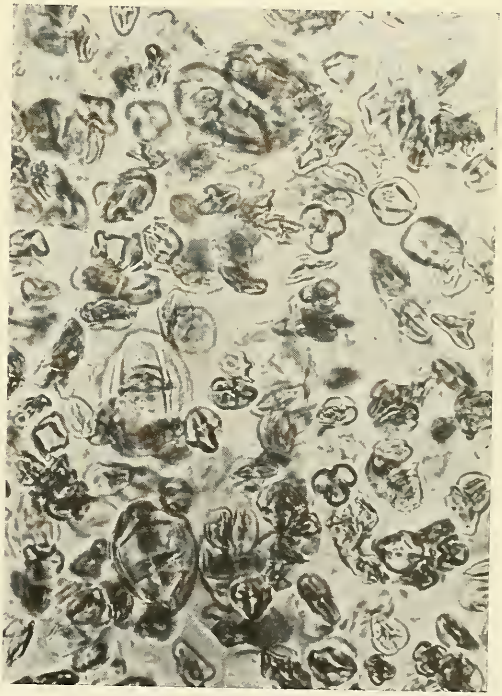
UNOBSERVED except for their work of organic decay and dissolution, bacteria flourished in soil, water, and air. Small invertebrates—worms, snails, crayfish, and insects—consumed the plants, each other, and microorganisms. Water dwellers included carnivorous and insectivorous fishes, permanently gilled salamanders and other amphibian larvae—many of which were herbivores before they took to preying upon worms and insects on shore or in the trees. Aquatic turtles, actively pursuing prey, feeding on vegetation and carrion, or lying submerged on the bottom, ready to snap at any passing morsel, shared pool and stream with crocodiles and alligators—to whom any



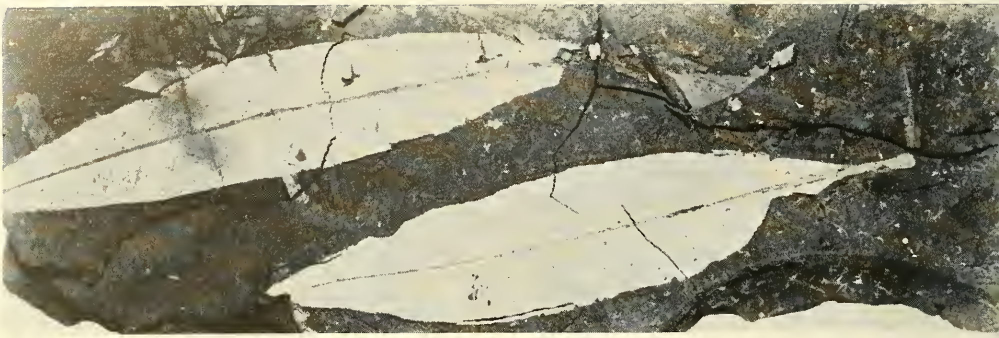
tire region was lush and subtropical in vegetation during
e middle Eocene, although the rainfall was only seasonal.



DERMIS of one of the savanna grasses, well adapted to a
tively dry climate, is shown above, magnified 400 times.



POLLEN GRANULES, densely distributed throughout lignite beds of Geisel Valley, are shown at magnification of 1,000.



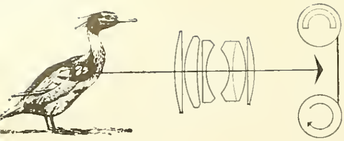
LEAF IMPRESSIONS—probably of a member of the wax myrtle family—are seen slightly larger than natural size in the photograph above. The fossil leaves shown at right reve even the very fine details of their venation and structu

kind of meat, living or still, was welcome. Others among the reptiles—such as the ground- and tree-living lizards—bit-players left after the collapse of an impressive Mesozoic production—were mostly chasers after insects and their larvae. High-domed land tortoises, of very catholic tastes, trudged along the damp forest floor and probably also in the neighboring drier grasslands. Constrictors rested along low-lying branches, coils flexed to be thrown around any small passing mammal. These, the insectivores, the insect-, fruit-, and grub-eating lemurs and tarsiers, and the mainly herbivorous rodents, were also stalked by weasel-like and civet-like early carnivores. The huskier creodonts preyed on primitive tapirs and bulky forest horses—both of which, although primarily interested in the soft forest vegetation, ventured out occasionally to graze on the harsher savanna grasses.

During the day, the aerial realm was filled with chattering, screeching, gaudy birds; most of them were insectivorous, but some ate fruits and others depended on small reptiles and mammals. The marsh-dwelling wading bir speared fishes and tadpoles. Ground-nesting bustards h in the tall grasses of the uplands. At dusk and throu the night, bats winged between the trees, avoiding obst cles and capturing night-flying insects. And, year aft year, predator, prey, and plant fell in this lush setting, be preserved by the seep of calcareous water through t valley's developing lignite beds.

In closing, it should be emphasized that the Geisel V ley certainly fostered many other animals beside tho that have been uncovered as fossils. Yet, these excav tions give us a remarkably complete picture not only of t biotic community, but also of the climatic and physical cc ditions prevailing during middle Eocene times in centr Germany. The recently renewed work at those deposits h yielded a great deal of new and as yet largely undescrib material. No doubt, our knowledge of this region and o capacity to reconstruct the picture of this particular peri with added detail will be greatly increased in the futu

FOSSILIZED LEAF of a parasitic plant from mistletoe family is seen here. Geisel Valley fossils were so well preserved because destructive humic acid given off by plant decay w neutralized by calcium present in ground and surface wat



NATURE and the CAMER

Understanding of focus improves photo

By David Linton

Photographs are possible because the light rays reflected by the subject are concentrated and "resolved" by the lens into an image that is a miniature reversed copy of the original. For every subject visible in front of the lens there is a corresponding image behind the lens—upside down and backwards. It is also reversed in a third dimension—an object close to the front of the lens will project its image farther behind the lens, while the image of a faraway object seems closer to the back of the lens.

Behind every lens is a miniature world of images, which reproduces the outside world that the lens "sees." These images are all there, suspended in space, as long as the lens is open. What we do when we "focus" a camera is simply to decide which of these many images will be intercepted by the film at the point where they are resolved or "sharp."

This can be demonstrated by taking the lens from a camera (or using a magnifying glass) and propping it on a table so that it points toward a window. Shutter and diaphragm should be open. Put a white card in the position usually occupied by the film, and one can see on the card the images projected by the lens. It may be necessary to shade the card from any light not coming through the lens, so the projected images will not be washed out.

If one starts with the card well behind the normal film position and moves it slowly toward the lens, the images of nearby objects will appear first, followed by those of objects farther away. The images of distant objects—the view outside the window, for example—appear last, as the card is brought closer to the lens. Finally, a point is reached at which images disappear.

The point where the images of the most distant objects are resolved is called infinity: the distance from that point to the lens is the focal length of the lens. The conventional, "normal" lens is one with a focal length approximately equal to the diagonal dimension of the film. The field of the lens is circular, even though the film is rectangular. Thus, this diagonal is actually the diameter of the field that the lens forms.

Focal length is a built-in characteristic, determined by the lens design. Other lens characteristics—such as "speed" (or light-gathering power) and angle of view—must be designed into the lens in relation to its focal length.

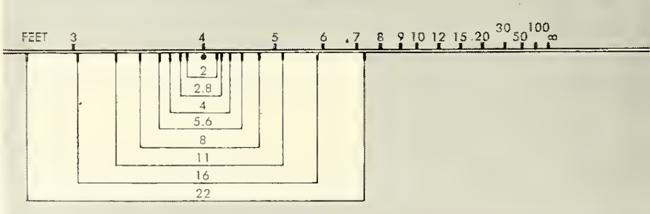
The quantity of light that a lens can gather and can project onto the film depends on how big the lens is. A lens of longer focal length will produce a larger image, but the lens must be correspondingly larger in diameter to produce the same brightness. In other words, the speed of a lens—the measure of the brightest image it can produce—is determined by its diameter in relation to its focal length. This is expressed in a ratio called an "f number," because the letter "f" is used to stand for the focal length, in a sort of shorthand fraction. An f/1 lens is one whose maximum opening is the same as its focal length (f divided by 1). An f/2 lens has a maximum opening one-half of its focal length (f divided by 2), and so on. Since the f number is really the bottom part of a fraction, a large diameter is represented by a small number and vice versa.

The maximum aperture and focal length of a lens are usually engraved on its mount. I should say "effective maximum aperture," because modern lenses are so complex that these elementary rules are subject to some exceptions. On European and Japanese lenses, the values are generally given thus: "1:2.5 = 3.5cm." An English or American lens would probably be marked "35mm., f/2.5." Both designations mean the same—the lens has a focal length of 35mm., and its maximum aperture is 1/2.5 of that distance, or 14mm.

The notion that fast lenses are bett than slow ones is a currently widespre misconception. It simply is not true. A tually, a fast lens is a good investme only if one uses it fairly frequently its maximum diaphragm opening.

Film is flat in most cameras, but t field of a lens is not naturally fla the designer has had to make it flat wi in certain limits. These limits determi the lens's angle of view. Thus, a le designed to render a broad angle of vi on a flat plane is called a wide-ang lens, while a lens that flattens only narrow angle is called a long-focus (telephoto) lens. The latter is simply longer lens—such as one would use a camera that takes a large-sized fi —but in telephoto applications only t center part of its field is used. A 100m lens on a 35mm. camera is a telepho lens, while a 100mm. lens for a 2¼ x 3 camera is a "normal" lens and a 100m lens designed for a 4 x 5 camera is wide-angle. The lens-to-film distan and image size are the same with three: the difference is in how much what they see is projected flat.

As described above, a lens will proje a flat object (the "subject plane as a flat image (the "focal plane within certain limits. Objects in front or behind, the subject plane will be vi



Depth of field scale for 50mm., f/2 lens is shown with lens focused at 17 feet, *top*, hyperfocal distance for f/11. At 4 feet, *below*, sharp zone is reduced. Photo, *rig* shows how a wide opening may be used give sharp subject and soft environme

David Linton's by-line has appeared under photographs in all the nation's leading magazines. His camera column is a regular feature on these pages.

ble in the focal plane, but their images will not be sharp: these images are "out of focus." It is possible to make such images sharp by moving the focal plane toward or away from the lens, but to do so will throw the principal subject out of focus. If the size of the lens opening is reduced, however, these unsharp objects can be brought into focus without disturbing the sharpness of the subject plane. This procedure is called "stopping down." It gives us, instead of a narrow subject plane and focal plane, a "zone" of sharp focus at the film. The middle of this zone is the sharpest, but the difference in sharpness will not be noticeable for a certain distance in front and in back of that point. If a fixed value of unsharpness, measurable with sensitive instruments, is taken as a limit of tolerance, we can make up a table showing the size of this zone of acceptable sharpness—or "depth of field"—for every combination of working distance and lens aperture.

Such depth of field tables are published for every lens, and scales are engraved on the lens mount or around the focusing knob on most cameras. It is surprising how few people know how to use them. A glance at one of these scales will show that, as the working distance increases, the zone of sharpness at any given lens opening increases in size. Also, the zone of sharpness always extends about twice as far behind the plane on which the lens is focused as it does in front of that plane. A handy way to visualize this is to draw two lines in pencil across a heavy rubber band and then make a mark one-third of the distance between the two lines. Stretch the band and see the zone of focus (the region between the two lines) grow as the focal point (the mark) moves away.

Many people believe that the right way to bring a camera into its best focus is, first, to focus on the subject and then to stop down the lens to make the image sharper. This procedure conceals two assumptions, neither of which is always correct. Unless the object being photographed is flat and faces the camera squarely (like a billboard), it may be best not to focus on it. Rather, one should first locate the nearest and farthest objects that should be sharp (the closest and most distant people in a picnic group, for example), and

Great distance from lens to ground in aerial photography assures deep zone of sharpness without use of small aperture.

then select a point of focus and a lens opening that will include both extremes in the zone of sharp focus.

This technique of zone focusing is easiest to use with a range-finder camera. Optical range finders were originally developed for measuring distances rather than for focusing cameras, and they may still be so used. Simply focus on the farthest object and note the distance to it as shown on the range-finder scale. Next, focus on the nearest object and note that distance. Then set the camera so the same aperture marking is opposite each of these distances. This is the maximum aperture that will bring both extremes into the zone of sharp focus: it is usually the one to use. The shutter speed needed for both the film being used and the amount of available light can be read opposite this aperture on a light meter. If the speed one finds by this method is impracticable, it may be necessary to use another aperture, change film, or eliminate something from the picture.

Stopping down farther will not make the image any sharper. To be sure, it will make the zone of sharp focus deeper, but this is not always useful. Furthermore, it *may* make the image less sharp, especially with a fast lens. Fast lenses are admirably designed to do a good job at maximum aperture, but they pay for this by beginning to lose sharpness when stopped down beyond a given point. This point varies from lens to lens, but is usually about two-thirds of maximum opening. Slow lenses (those with smaller maximum openings, represented by larger f numbers) are likely to be sharper than fast lenses stopped down.

Zone focusing, as described above, can be used to advantage even on subjects that will not stand still long enough for one to read off nearest and farthest distances. If, for example, the object is to photograph the finish of a horse race, the camera may be set to include in the zone of sharp focus everything on the finish line from the near rail to the far one. One is then reasonably sure of catching the winner in this zone of sharpness.

The folly of unnecessary stopping-down is particularly obvious when everything in the picture is far away, as is the case in pictures taken from the air or photographs of distant landscapes. It does no good to have a deep zone of focus if there is nothing in the zone. Similarly, there is no point in stopping down when the zone of focus already extends to infinity. It is true that stopping down will bring the foreground into focus, but for every foot of depth gained in front of the focal point, the sharp zone will also include two feet behind it —wasted when everything behind the subject is already in focus.

THE sharp zone is deepest when it ju
reaches infinity. This setting c
be found on the depth of field scale l
focusing the camera so that the select
aperture is opposite the infinity mar
The point on which the camera is th
focused is called the *hyperfocal d*
tance: it is the distance that gives t
greatest depth of field possible for th
lens and aperture. On the other end
the scale, the same aperture will be o
posite the near end of the sharp zone.

The use of zone focusing and hype
focal distance (which is simply a zo
that ends at infinity) will often perm
the photographer to use higher shutt
speeds or slower film, and thereby pr
duce a sharper image. But it is by
means necessary or desirable to ha
everything in a picture sharp. The e
does not see everything sharply: diffe
ences in sharpness help us to percei
depth, in a photograph as in real lif
This is one reason why old-style adve
tising photographs, uniformly sha
throughout, looked so unreal. There
no basis for the belief that a sha
image is inherently "better" than an u
sharp one. Each has its own power
convey information or to set a moo
Focus is part of the language of photo
raphy. The reason for learning how
works is to be able to use it—like a
other technique—to make each pictu
say what one wants it to say.

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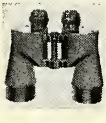

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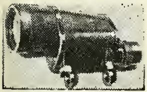

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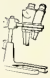

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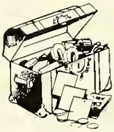

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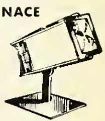

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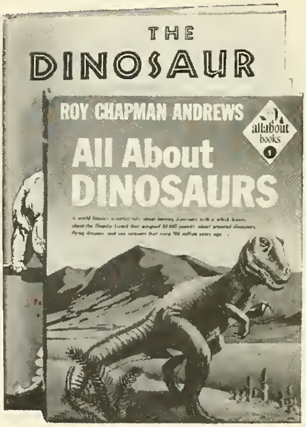

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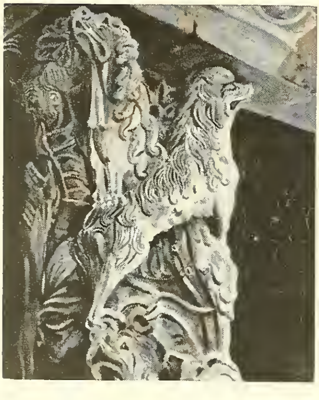

COVER: In the fourteenth century, two hundred years after it was comp
Abbot Aymeric de Peyrac wrote of the *trumeau* at Moissac, France: "... re
the most beautiful, and most subtly wrought ... and even supposed to have
made miraculously rather than by a man, especially a simple abbot."
GUGGENHEIM has painted the top third of the twelve-foot *trumeau* to illu
a typical piece of Romanesque art, which reached its climax during the tw
century in Europe. Here a lion and a lioness merge intricately with the f
of St. Paul. Rich in symbolism, both Christian and that borrowed from c
times, Romanesque sculpture abounded in real and imaginary animals c
with a wealth of emotion and detail. A study of these beasts begins on pag

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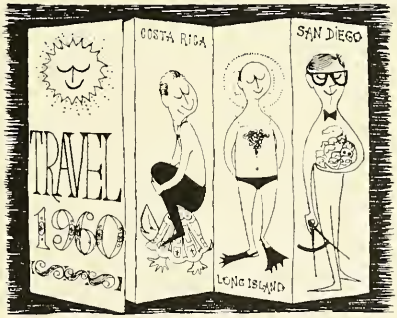
Museum Memo

By John O'Reilly

EARLY FALL brings the Museum's practitioners of the natural sciences back to desk and laboratory from great variety of summer activities, which take them to eserts and jungles, plains and mountains in many parts f the world. Summertime is their extended research time nd some of them may extend their research to the top of a ountain in Arizona or all the way to New Guinea. Many ombine their vacation period with field research. A true erpetologist cannot be happier than when hunting frogs, rtles, or snakes and, no matter where an ornithologist oes, he seldom puts birds out of his mind.

When you ask most people what they did during the sumer, you get the usual answers concerning boat trips and shing, cabins in the mountains, or sojourns at the sea-ore. But ask a museum scientist how he passed his sumer and you are likely to get a startling answer. This fall, embers of the American Museum's scientific staff had ome ready answers—but the answers frequently demanded rther explanation.

James A. Oliver, Director, and harles M. Bogert, herpetologist, eported that they had been down Costa Rica hatching turtle eggs. mplification established that they ad not been hatching the eggs emselves but had gone down there s members of the Brotherhood of e Green Turtle, an organization evoted to re-establishing that reatened animal throughout its rmer range in the Caribbean.



The green turtle was to the Cabbean what the buffalo was to e western plains. Early explorers nd the shiploads of settlers that followed slaughtered them r their meat. In time they were wiped out over much of e area. Islands where thousands once came to lay their ggs know them no more. For their part in the movement bring them back, Oliver and Bogert made arrangements send hundreds of baby turtles from hatching sites in osta Rica to the Lerner Marine Laboratory, the Museum's tation at Bimini, Bahamas. There the little turtles will be eleased at various ages in hopes that, as adults, they will eturn to Bimini to lay their eggs. If the plan works, the ig turtles can be brought back to their former range, uch will be learned about their life history, and an conomic resource will have been renewed.

Malcolm C. McKenna, paleontologist, went out West in his Cessna airplane to look for fossil bones. He explained that he doesn't see the bones from the airplane but that the view from the air is a great way to locate formations in which fossils are apt to be found.

"It's wonderful for finding outcrops," he said. "You can see the color of formations: you can tell whether a ledge is eroding rapidly or whether there is a farmer somewhere around with a shotgun."

McKenna and his co-workers settled on a site in western Wyoming where for two months they toiled at digging up 130 tons of sediments. transporting the rocks to a creek where they were washed in screened boxes. The result of the summer's work was 20,000 usable specimens, including over 2,000 mammal remains, among them some shoulder blades of Multituberculata.

Richard G. Van Gelder, mammalogist, passed the summer on the West Coast measuring skunk skulls. For three months he measured skunk skulls in museums all the way from Victoria, B.C., to San Diego, taking about 30,000 measurements on 850 specimens. He also took some 500 photographs of the skulls. To some this might seem a dull way to pass the summer but to Van Gelder it is an important part of a long-term undertaking. He is in the midst of a three-year project involving the classification of the skunks of the world or, rather, the skunks of half the world for there are no skunks in the Eastern Hemisphere. He will do it again next summer.

Brooks F. Ellis, micropaleontologist, was out taking sediment samples from the bottom of Long Island Sound as part of another long-term study. Robert L. Carneiro, of the Anthropology Department, was off to Peru to study a group of Indians and won't be back for a year. Other staff members went to the Museum's various field stations to study everything from embryonic frogs and toads to pine trees. Still others were at scientific conferences here and abroad.

On the whole it was a splendid summer. A good time was had by all scientists. They brought back lots of data and material for subsequent interpretation. Now for the winter months, devoted to the equally important. if less exciting, aspects of the natural sciences in office and laboratory.

The American Museum is open to the public without charge every day.

Review

A Christmas survey of the year in children's science boo

In presenting their first annual survey of children's science books, the editors of Natural History are focusing attention on one of the most significant developments in American education: the rise of science to a prominent position in the school curriculum.

Such a review would have been impossible a generation or so ago. Then, there were far too few books to justify the effort. One widely used list of that time, a list prepared especially for teachers, included only about two dozen titles—and it covered a five-year publishing period, from 1930 to 1935. Contrast that dearth of material with the situation today. The thirty-nine books reviewed below represent a selection from over one hundred and fifty titles received from publishers, all appearing during an eleven-month period. This is a trend that has accelerated sharply during the past few years: editors refer to it, quite correctly, as an "explosion" in the publication of science books for children.

I can think of a number of reasons for this notable change. Not the least important is the startling impact of the launching of Sputnik I in 1957. We are heavily indebted to the Russians for accomplishing that feat, which had the effect of arousing us from a long somnolence and emphasizing to people, who should have known it all along, the vital role of science education. Since then, it has become increasingly obvious that the nation's welfare involves not only advances in the glamor fields of space exploration, electronics, and other applied sciences but also involves the training of investigators devoted to basic research—upon which, in the last analysis, all technological progress depends.

In other words, the marked rise in the demand for children's science books is one sign of a new and somewhat belated concern with the quality of American education. The demand is certainly not being met in a systematic or completely satisfactory way. Scientifically sophisticated publishers are about as rare as scientifically sophisticated Congressmen, industrialists, or advertising executives. We would be much better off if some of the vacuous books currently on the market had never been written and there is plenty of room for pointed and outspoken criticism, such as that to be found among the reviews in this survey.

But this picture also has a bright side. The book trade stands up rather well when we consider what is going on in other areas presumably devoted to the public interest. Take commercial television, for example. Last year, buried under a mass of shows in which practically everything was cheap but the production costs, we had only a smattering of science. The list included one-hour programs sponsored by the Bell Telephone Laboratories and "Conquest," a series of twenty half-hour programs on the Columbia Broadcasting System. As far as time devoted to basic science is concerned, this year's offerings will be even more meager. The Bell programs are still with us for a grand total of two hours. But "Conquest" has been killed because, although it satisfied many persons (audiences of ten million or more), it failed to satisfy sponsors and TV officials in search of more lucrative programs.

Viewed from this broader perspective, the publishers make up a comparatively distinguished group. Among them we can see the profit motive working in a relatively effective manner—to the advantage of all concerned. They are sensitive not only to the mounting demand for more children's books about science, but also to the need for setting higher standards of quality in writing and production. For a full appreciation of the progress that has been made, it is necessary to compare the best books of the 1930's, books like *Romping Through Physics*, *Talking Wires*, and *Television Today and Tomorrow*, with today's publications. When it comes to presenting young students with serious and accurate accounts of scientific achievements, we already have a reasonably wide choice of well-written books—and the choice will be wider in the near future.

Nonetheless, a considerable proportion of children's science books today is clearly not up to par—and for this we cannot always blame the publishers. The need for articulate and literate science writing is perhaps more urgent than it has ever been before. Yet the number of writers who are at once scientifically trained and skilled in the art of presenting science to nonscientists is pitifully small. A hundred persons would be a most generous estimate. For this reason, among others, the National Association of Science Writers has been working actively with universities and publ
on steps designed to increase the s
of such writers, while the Na
Science Foundation is considering l
can best help promote the public u
standing of basic scientific researcl

Book publishers are obviously n
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encouraging exceptions, it has not
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One result is the considerable ur
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rate as well as outstanding efforts.

Another result is a certain la
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and Mars are undoubtedly ex
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does *not* include a book on space e
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We could also use more imagin
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surprise that "new" illustrations
often slightly modified versions of
that have been used over and over a
A book about research developi
demands illustration with a fresl
proach as well as fresh writing.

A final point. It is possible to d
tice to the subject matter and stil
completely to convey the spirit of
research. The conventional approa
to concentrate on the established

ngs of scientific investigations—say, the lements of cell structure or the laws of notion or heredity—without presenting he facts against a dynamic background f investigations under way today. This s essentially an armchair approach. The uthor need not, and rarely does, spend ime with scientists who are at work on urrent problems as part of their daily fe. So his writing tends to have an abtract, once-removed quality—remote rom the laboratory and from living peole engaged in the study of natural henomena. This remoteness is not ideal designed to help foster a continuing nterest in science.

Today, as in the past, one thing is bundantly clear. Children are not the nly ones who need educating; we all o. Children's science books have improved and will keep on improving. But rogress will continue to be slow and aphazard until more parents, teachers, riters, publishers and other nonscientsts take science seriously enough to ive it the attention it deserves. On their de, more scientists will have to take ore seriously the nonscientist's need for alatable information, even if this means e frightening prospect of consultations ith writer and editors.

The day has long since passed when a oy or girl could graduate from school ith little or no knowledge of basic reearch and still function as an intellient citizen. Children's science books epresent an important way of providing at knowledge and establishing an apreciation for learning in all areas. The eviews that follow in this survey should elp all of us in the science field keep ese objectives firmly in mind.

JOHN PFEIFFER

Astronomy

N REVIEWING THIS SELECTION of astronomical books for children, I was leasantly surprised to see many that re adequate expositions, honestly prouced. But the exceptions are sad. Vhen children first start to school, they earn from their teachers that all knowldge is in books. Many things that chilren learn from books are entirely utside their own experience and beond the possibility of personal confirmation. They must accept the book's authority wholly on faith. What a tremendous responsibility, then, for the writer and publisher to make absolutely certain that their work is correct and exemplary in every way!

Book designers and illustrators also must respect their audience. For example, I am inclined to judge a book by its cover: usually, if it is worth reading and keeping, it is worth binding well. But, all too often, this leads to error. More than one of the books in this list was a fine piece of writing put in a bad package. More than one was beautiful to behold, but the text was sloppy and inaccurate. Which will sell more? The beautiful ones, I fear, leaving the ill-set gems to languish on the shelf.

The history of astronomy is highly dramatic, but can be made dreadfully dull by the chronicler. Happily, *The Kingdom of the Sun*, by Isaac Asimov (Abelard-Schuman), is a refreshing, unpretentious, highly readable account of the development of man's knowledge and understanding of the nature of the solar system from early Babylonian observations to relativistic explanations of the subtleties of the motion of Mercury. Professor Asimov writes as if he were personally telling a very interesting story to you in your living room. Over three-score astronomers are revealed to be human beings, rather than mere names. Each one of their contributions is placed in the context of contemporary understanding, so that its impact and significance may be fully appreciated.

This entertaining narrative, alas, is poorly packaged. The jacket is unimaginative and uninviting of a second glance and the binding cheap. The skimped production seems unfair to the hard work and skill of the author.

Terry Maloney, the author of *The Sky is our Window* (Sterling), is a Fellow of the Royal Astronomical Society and is described on the dust jacket as one of England's leading astronomers. His training is evident in this book, for he has treated a wide variety of subjects with skill and accuracy. Nothing is complex, for the author has confined himself to a light survey of astronomy. As he says, "This is not a book of formal instruction on astronomy. It is not intended as a textbook or even a guide to the heavens for the observer with a telescope. It is simply intended as a book to be read for pleasure." One's enjoyment is heightened by a profusion of photographs and some of the author's own paintings (several in color), although these are not as closely connected with the text as they should be.

Inevitably, opinions will differ on which subjects to cover in such a survey. This reviewer misses any discussion of modern ideas of stellar evolution as such, and their relation to our knowledge of the structure of the galaxy. There is the standard description of a comet, but no mention of the probable basic form of a comet, developed by research in the last decade. Indeed, almost the only gesture toward the inclusion of thoroughly up-to-date information is made with a few paragraphs on radio astronomy. In spite of these few differences of opinion, Maloney's book can be highly recommended to anyone, adult or interested high school student, who has an intelligent curiosity about astronomy and who wants to be introduced enjoyably to the space that man is setting out to explore.

Margaret Hyde's little book, *Exploring Earth and Space* (McGraw-Hill), leads a youngster on an expedition to all parts of the earth, inside and out. Earthquakes and volcanoes are explained with examples of actual occurrences. Antarctica, the oceans, and the atmosphere are discussed. Solar energy and the sun itself are treated, along with rockets and satellites and radio astronomy. If one reads this slowly, as a child might, he will not feel that too much is crammed into a small space. The pace is rapid but exciting. The illustrations convey more information than is usual in the case of line drawings, but the captions are a little too earnest. They would do well if applied to actual photographs, or made more general.

A book of this size and scope can give a youngster an idea of the interconnections of many different sciences all working toward an understanding and harnessing of our planet and its environment. Mrs. Hyde exhibits an uncertain knowledge of solar features, but this is a relatively minor drawback. She appears to respect her readership and to have their interests in mind.

A Publisher's Note at the back of *The Story of Planets, Space and Stars*, by Gaylord Johnson (Harvey House), informs the reader that it is one of a series of books in the "Story of Science" Series, aimed at children in grades three through nine. The type is large; illustrations are plentiful; the volume is light, easy to handle and attractively bound. Because astronomy is filled with unusual words from the Greek and the Arabic (which have frequently been Latinized), one good feature of this book is an attempt to indicate the common

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This year, at the suggestion of its Scientific Staff Advisers, NATURAL HISTORY is devoting December's reviews to a discussion of 39 current science books for older children. A general introduction has been written by John Pfeiffer, himself an experienced science writer, while Drs. Walter Fairservis, Kenneth Franklin, John Imbrie, Jack McCormick, and Evelyn Shaw—all associated with THE AMERICAN MUSEUM—have reviewed books in their special fields. It is the Editors' hope that such comments, to be published every December, will be useful not only to gift-giving adults, but also to teachers and librarians as a latter-day Diogenes' lantern lighting the crowd of science publications.

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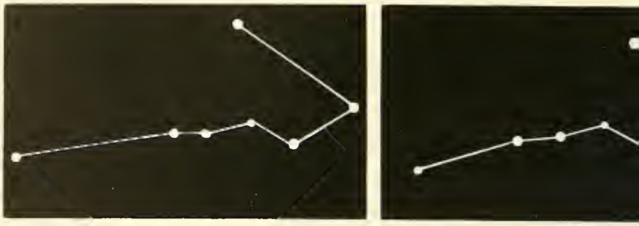


BIG DIPPER'S SHAPE, past, present, and future, is shown

pronunciation of most of these words.

Beyond this, there is little complimentary to be said. One chapter, entitled "How the solar system keeps going," logically begins with a mention of Newton but immediately turns to the appearance of the sky as affected by the earth's rotation and its atmosphere. The explanation of "how" occupies nineteen lines, while the rest of the chapter is devoted to miscellaneous effects of gravity and descriptions of meteors and comets—the latter incorrect. The discussion of co-ordinates and time in another chapter is interesting but unnecessary for younger children, because it contains too much material incompletely explained. A mistake in proofreading that occurs here, "One degree (1/90 of a circle) . . ." may contribute to confusion. In the discussion of the sun, the source of energy is incorrectly attributed to fission rather than to fusion: "The sun splits hydrogen atoms in a reaction chain." The process is also stated as taking place in the sun's atmosphere rather than at its center. Further confusion arises when "the hydrogen particles are now fused into atoms of non-explosive helium gas," for the entire process as described is illogical.

A "young beginners' book of astronomy," *The Stars for Sam*, by W. Maxwell Reed (Harcourt, Brace) was originally published in 1931, and has enjoyed longevity and a good reputation, at least among non-astronomers. It has now been revised and the editor states that the guiding purpose of the revision has been to bring the material up to date while retaining "the qualities that made *The Stars for Sam* so appealing to so many young people over the years."

Unfortunately, awareness of the "good reputation" of the original is only preparation for keen disappointment in the revised version. In general, the writing is uneven, and sometimes tantalizing. In a discussion of falling bodies may be found "By an interesting and simple method the distance a rock will fall at the end of any number of seconds can be determined." This statement is followed by results, but there is no indication of the "interesting and simple method."

There are several examples of faulty logic: "If anyone lives on Jupiter, he must be as queer as any prehistoric fossil that has ever been discovered,
there is a dense atmosphere that i
ways full of yellow and red clouds".
"All present evidence points to the
that the Russians did hit the mo
although in reality it will be diffi
to be absolutely certain since the ro
ceased sending signals once it hit .

With respect to the astronomy, a
not well either. The discussion of
sun is vague and actually incorrec
many places. Several pages are use
discuss a theory of the origin of
solar system, which has been disc
ited for decades. A photograph show
stages of a lunar eclipse is mislabe
purporting to exhibit the phases of
moon. Three different periods for
moon's revolution are quoted—with
certain indication of which pheno
non goes with which period—and
of them is wrong.

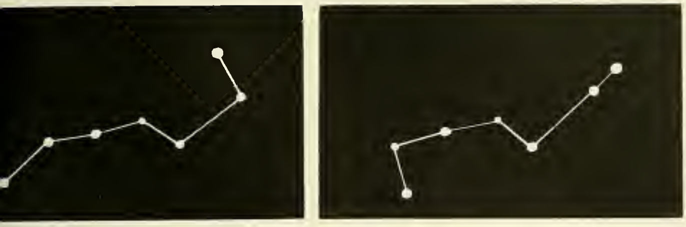
The Editor's Note acknowledges
assistance of two competent men in
tronomy. It is inconceivable that eit
one saw very much of the finished
sion of *The Stars for Sam* or that
they did, their advice was taken. On
them, intimately associated with H
vard University for many years, wo
certainly have pointed out that
Harlow Shapley has been retired
Director of the Harvard College
servatory for nearly a decade.

The revised edition of *The Stars*
Sam cannot be recommended.

KENNETH L. FRANK

Geology and Paleontology

THERE HAS RECENTLY BEEN an unp
edented demand by young read
for good books on technical subjects.
looking at a dozen books in the re
tively narrow field of geology and pa
ontology, it is refreshing to see t
some few authors and publishers
facing this demand with imaginati
For the most part, however, the wo
are wide of the mark, poorly present
or inaccurate. Obviously, one must c
tinue to be vigilant in choosing wor
while reading for young people, even
this specialized sector of science.



Intervals are 90,000 years (from *The Sky Is Our Window*).

Many of the books are evidently watered-down versions of college textbooks, and this, in effect, is their flaw. For in such a case, the author is forced to cover his topics too skimpily and the result, through oversimplification, tends to be misleading or confusing. The more successful books in this selection are those that sacrifice breadth of coverage for depth in a limited area, and present the material with imagination.

From Bones to Bodies, by William Fox and Samuel Welles (Walck), provides a general history and description of paleontology. Starting with the thesis, "A Rat is Like an Elephant," the authors cleverly and smoothly explain the purpose, methods, and achievements of paleontology. Their approach, while simple, is sound: evidence used in reconstructing past life is illustrated first in a general way, and then with photographs of work in three actual case histories. The result is distinguished: accurate, interesting, well organized, and smartly illustrated.

Another introduction to paleontology, *Before and After Dinosaurs*, by Lois and Louis Darling (Morrow), is addressed to rather younger readers. The book is superbly illustrated with original drawings so arranged that text and illustration support each other. By restricting their theme, the Darlings have been able to present a concise but informative book, although I feel the work would have been more interesting if technical detail, some of which is unnecessary, had been replaced by comments on the mechanisms of natural selection and evolution. Also, there is perhaps too much stress on peculiarities and "wonders," of which the book tends to become merely a compilation.

A junior treatment of historical geology in textbook style, with emphasis on fossils, is provided in *The Story of Earth Science*, by Dr. Horace G. Richards (Lippincott). Richards, a recognized authority, covers his topic with accuracy. The later chapters on minerals are brief, but well organized and useful for identification by junior collectors.

A sharp contrast is *On the Face of the Earth*, by Marion Gill MacNeill (Walck), a shallow summary of the evolution of earth and the life on it. The author fails to qualify uncertain theories and occasionally skirts hard fact with vague innuendo or worse: ". . . ocean tides, stronger and higher than we can imagine, swept over the rock surface of the earth—washing, beating and grinding the salt-bearing rock into soil . . ."; or, "Scientists believe, however, that some of the trilobites may have changed enough to survive—not as trilobites, but as lobsters and crabs. . . ." The text as it stands fails to give a clear and accurate picture.

Turning now to the areas of general geology and geophysics, three books, happily on a higher level, should be noted. The first is *Great Mysteries of the Earth*, by Charles H. Hapgood (Putnam). This is a bold venture, presenting in simple language the arguments surrounding the major problems of earth science—for example, the permanency of ocean basins, the cause of glacial periods, and the origin of continents and mountains. It is generally well written and I think will arouse curiosity to know more. But in translating the material into a readable volume for young people, Hapgood has risked giving some mistaken impressions, as when, discussing the ". . . mystery of mammoths . . . ," he has incautiously, as a nonprofessional, imposed "mystery" on a subject where none exists. Despite such excursions as this, Hapgood has produced a book that should both stimulate and entertain his readers.

The Earth for Sam, by W. Maxwell Reed, revised and edited by Paul F. Brandwein (Harcourt, Brace), is an updated version of a classic survey of the evolution of our planet and the life it contains. It covers a tremendous amount of ground, and is, therefore, limited in the depth with which any single topic can be covered. Thus, it runs the risk of confusing the reader—as, for instance, in the first chapter, where several theories of the earth's development are skimmed over. There are other faults, as well. The geosyncline concept—one of the most important in geology—is covered in one sentence. Again, the author mentions natural selection, but fails to identify or enlarge upon this phenomenon. Although part of the book follows the various geologic eras chronologically, the Cambrian and Ordovician periods of the Paleozoic, and the Paleo-

(Continued on page 62)

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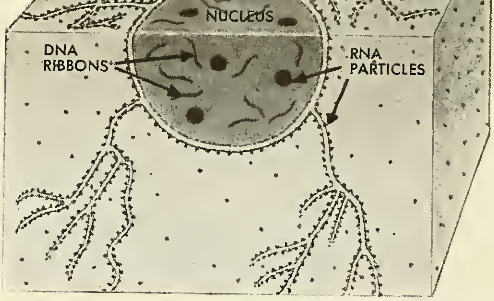
DNA

A complex molecule is deemed the master substance of life

By JOHN PFEIFFER



SIMPLIFIED DIAGRAM of an ordinary cell, *above*, locates seat of DNA in nucleus; RNA both there and in the cytoplasm.

COILED LIKE TINY SPRINGS in the nucleus of a fertilized human ovum are molecules of a remarkable compound known to biochemists as deoxyribonucleic acid or, more conveniently, as DNA. Half of this DNA has come from the sperm and half from the ovum itself. The sum of the two halves is exceedingly small, about two ten-trillionths of an ounce. But his minuscule total is enough to start a process in which a single cell, barely visible to the naked eye, will develop nto a mature human, a highly organ-zed community that contains some en thousand billion cells.

DNA represents the master substance of life and growth. It is heredi-ary material, the stuff out of which genes are made. Studying its structure and how it works has become a major objective of present-day research in he life sciences. In fact, biology is currently in the midst of a break-hrough as significant and exciting as the recent advances in physics that ed to the release of nuclear energy—and one important reason for this is cience's new insight into the nature f these complex molecules.

The more we learn about the DNA molecule, the better we shall under-tand the subtlest reactions of living matter. It is the basic unit, the "atom," f biology. For one thing, this nucle-c acid has the notable property of being able to reproduce. The cells n our bodies contain—in their genes -faithful copies of the DNA mole-ules in the ovum that was each of s at the time of conception. In other words, the DNA we inherited from our parents has duplicated itself many billions of times and it will continue to do so in our children and theirs for endless generations.

Reproduction is an enormously complex process, even at the molecular level, and DNA is an enormously complex substance. The discovery of its basic structure, one of the key advances of modern biology, came during the winter of 1953 at Cambridge University, England. The setting was hardly glamorous—not a shining laboratory but an unimpressive office in a sort of barracks, a space just large enough to hold two desks and a bookcase. Francis Crick and James Watson, a physical chemist and a biologist, found themselves engaged in a curious scientific game.

The game was a kind of jigsaw puzzle in three dimensions. The pieces of the puzzle were metal sheets, about the size of ordinary playing cards, but cut into different shapes representing six different substances. First was the sugar deoxyribose (the D in DNA); second was a phosphate group: and finally came four nitrogen-containing compounds known as "bases." Previous studies had shown that the DNA molecule is made up entirely of these six "building blocks," although it includes many of each type. Other evidence had hinted that the over-all shape of the molecule might be some sort of intricate coil.

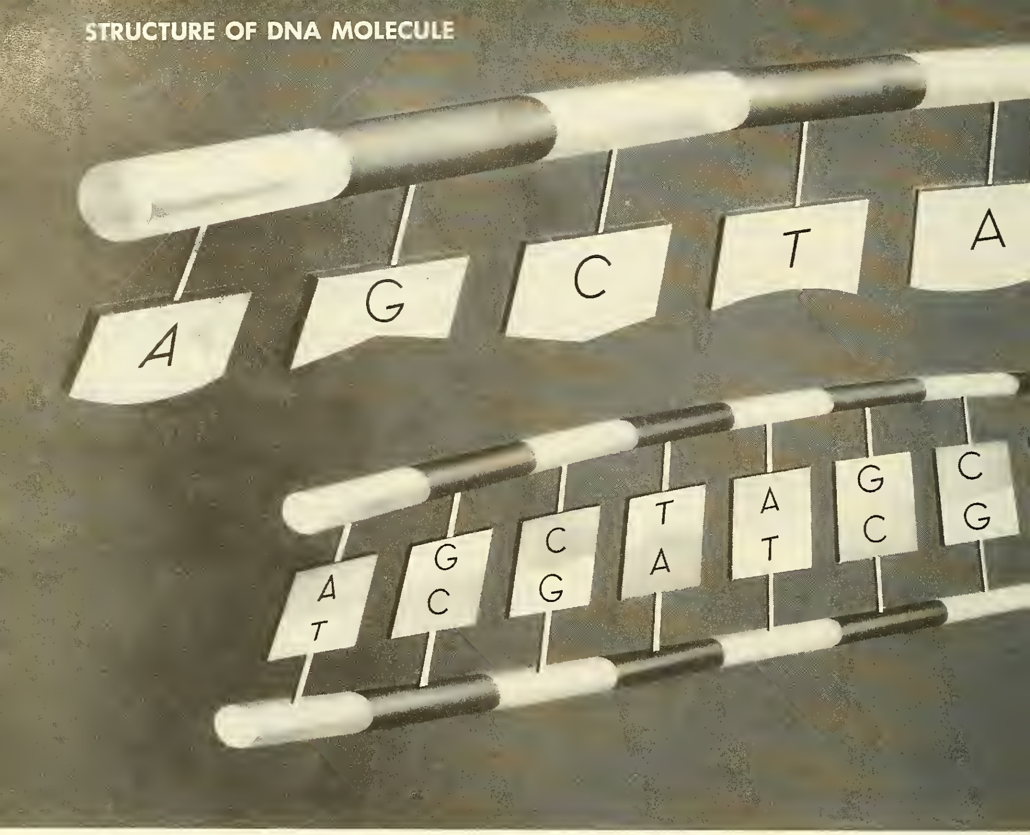
CRICK and Watson started fastening their metal sheets together in various ways, using rotatable joints to serve as analogies of chemical bonds. They spent more than two weeks getting nowhere before they finally hit upon a new way of putting the metal parts together to form a structure that checked with the known evidence. Then, in three days and nights of work, they assembled a model that resembled a piece of abstract modern sculpture—a double helix, two interconnected molecular strands twisted into a spiral-staircase structure.

Each strand in the model has as its foundation a long chain of alternate sugar and phosphate units. Attached to this chain at regular spacings, and sticking out as side groups, are sequences of four nitrogenous bases: adenine (A), guanine (G), cytosine (C), and thymine(T). Thus, one strand might be assembled as shown on the following page. The diagrams there represent only short sections of the chain, for each strand in a DNA molecule has thousands of these base side groups.

NOW, each such DNA strand has a similar structure, and each is attached to another strand by its side groups. In other words, the nitrogenous bases not only pair off with one another, but pair according to a definite rule that Crick and Watson deduced while building their model. Adenine can combine only with thymine, and guanine only with cytosine. So two attached strands look something like a ladder or a zipper (*below*, in same drawing on following page). If one thinks of the two lined strands twisting like a ribbon (*right*, in the illustration), one has a schematic representation of the DNA molecule.

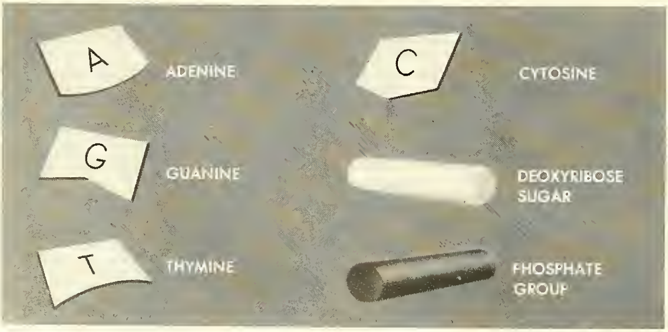
Investigators have been quick to note the biological implications of this model. Among other things, it offers possible mechanisms for the self-duplicating capacity of DNA. Imagine a solution containing the six essential DNA building blocks, including ample quantities of the four bases, plus a "parent" molecule of DNA. The two strands of the parent molecule have separated by some sort of unraveling

GIANT CHROMOSOMES from cell nuclei f a *Drosophila* salivary gland, *left*, how sequence of light and dark bands hat indicates location of particular genes—ribbon-like molecules of DNA.


STRUCTURE OF DNA MOLECULE

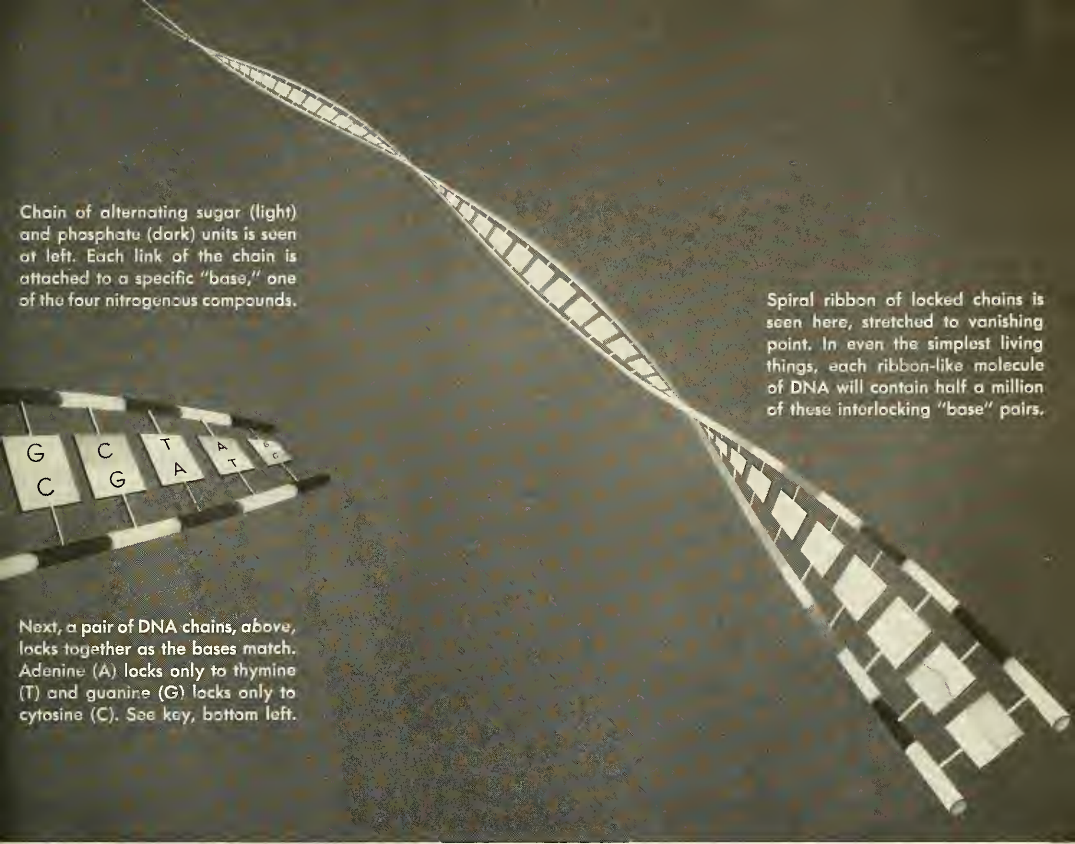
process. Now this solution, like most solutions, is a site of frenzied activity. Particles of the four bases are moving at high speeds in all directions. They collide with one another and with the unraveled DNA strands and, as a rule, they bounce apart after colliding. A free adenine particle, for example, bounces off an adenine or guanine or cytosine group attached to a DNA strand; but if it collides with an attached thymine group, there may be a neat fit and it may stick in place.

A sufficient number of appropriate collisions will thus produce two new DNA strands, formed on and fastened to each strand of the original molecule. In short, each of the original
strands is complementary to the ot
and effectively serves as a temp
or mold that determines the oth
structure. The result is reproduct
at the molecular level: two DNA m
cules exist where only one exis
before. Furthermore, because th
are billions and billions of collisi
in the solution every second, rep
duction may occur swiftly. Art
Kornberg of Stanford University
prepared special solutions in wh
DNA "breeding" actually takes pl
(last year he won a Nobel Prize
his work in this field).



The Crick—Watson model is of c
standing significance for anot
reason. Since DNA is the main her
itary material—the physical basis
genes—differences in its makeup
termine the differences among spec
These differences are extremely s
tle. In fact, the similarities are
more obvious than the dissimilarit

DNA exists throughout the v



Chain of alternating sugar (light) and phosphate (dark) units is seen at left. Each link of the chain is attached to a specific "base," one of the four nitrogenous compounds.

Spiral ribbon of locked chains is seen here, stretched to vanishing point. In even the simplest living things, each ribbon-like molecule of DNA will contain half a million of these interlocking "base" pairs.

Next, a pair of DNA chains, *above*, locks together as the bases match. Adenine (A) locks only to thymine (T) and guanine (G) locks only to cytosine (C). See key, bottom left.

range of living things. It comes in "packets," molecules of about 15,000 "base-pairs" each. At the lowest end of the scale of life, DNA is found in many viruses—for instance, in certain tadpole-shaped viruses so tiny that more than five billion of them would fit comfortably into a sphere no bigger across than the period at the end of this sentence. DNA is also found in bacteria, and in all higher organisms from amoeba to man. It is generally constructed according to the same pattern, a double helix of paired strands, made of the same half-dozen building blocks. Moreover, the foundation chains of alternate sugar and phosphate groups are always identically the same in basic structure.

THE subtle essential differences that characterize different species involve the base-pairs connecting the chains, the "rungs" of the DNA ladder. Broadly speaking, the higher we move up the evolutionary scale, the greater the number of base-pairs—that is, the longer the ladder. There may be packets containing some half-million base-pairs in the molecules of virus DNA, ten million in bacterial DNA, and perhaps ten billion or more in mammalian DNA. This is what we would expect, assuming that a more advanced species needs more DNA to transmit its hereditary traits to future generations, and this rule appears to hold in general.

But a word of warning is in order. Part of the excitement and challenge of biological research is its exquisite complexity; living things frequently fail to obey our most "logical" rules. To cite a stubborn fact, it apparently takes more DNA to form a lungfish than to form a man, and this striking exception to an orderly increase of complexity has yet to be explained.

Suppose that we had complete information (which we emphatically do *not*); that we knew the exact and complete sequence of base-pairs in the DNA molecules of every species on earth. Suppose, further, that the molecule packets of each species were attached and then untwisted to form a single continuous strip. In that case, we would have about two million such strips, because the earth houses an estimated two million species.

Now, according to current concepts, each one of these strips would be unique, in that its base-pairs would be arranged in a different *order* from those of every other species. In theory, we could study the strips one by one and "read off" their base-pairs as though we were reading information from a vast collection of ticker tapes. No two strips would read in exactly the same way and each would represent a distinct species. Thus a sequence starting "A-T, G-C, T-A, C-G, A-T . . ." might represent a jellyfish, "G-C, A-T, C-G, G-C, T-A . . ." might represent an elephant, and "T-A, A-T, G-C, C-G, G-C . . ." a man.

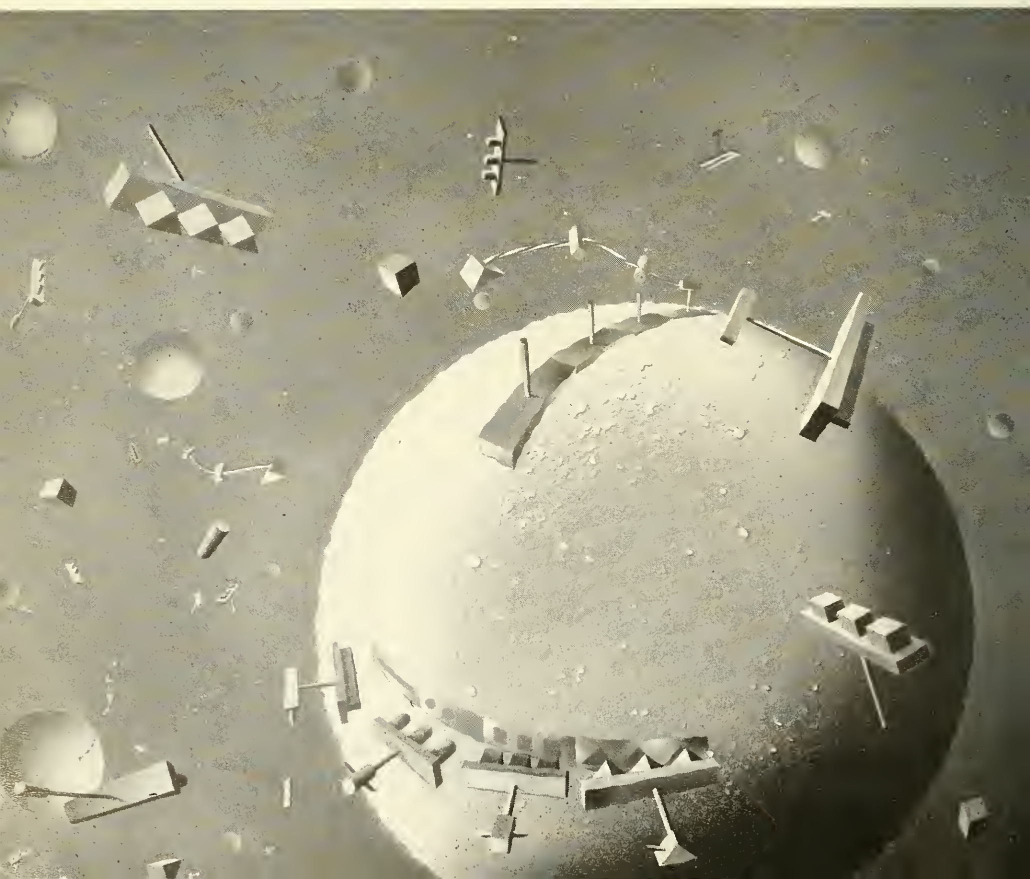
Getting down to finer detail, a complete reading of base-pair sequences—theoretically—would make it possible not only to distinguish strains within each species but also individuals within strains. This is another way of saying that, excepting identical twins, no two individuals have exactly the same order of base-pairs and every individual represents a unique combination of inherited traits. The differences between all living things, in this conception, may be traced to the four bases in their DNA molecules: the language of heredity may be written with an alphabet of only four letters.

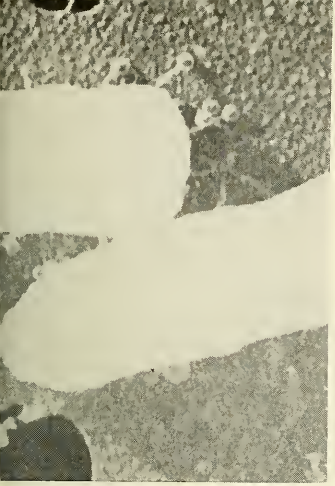
THE amazingly precise organization of hereditary material reflects the job it has to do. DNA contains the plan or blueprint for the construction of living cells and systems of living cells. Its specifications are expressed in a code of base-pairs that includes all the information needed to synthesize that all-important class of biological compounds, the proteins. The contraction of each muscle, the action of growth-promoting hormones, the flash of electrical signals along nerve fibers, digestion and the regulation of body temperature, even thought itself—in these and all other functions, the proteins play a fundamental role.

The cycles of life would be impossible if it were not for enzymes—substances that speed the rates of biochemical reactions without themselves undergoing changes in the process. And all of the six hundred to seven hundred known enzymes are proteins. So are the thousands of different antibodies, each designed to combat the effects of a different infective agent. Yet, for all their variety, proteins—like DNA—are composed of a relatively small number of building blocks, some twenty organic units known as amino acids. Here, again, DNA has a vital and complex part to play.

VIRUS ATTACK on bacillus, *above*, sho hereditary material on the loose. Ea virus—DNA or RNA within its sh

RNA "FACTORIES" are shown in analogy here. Each sphere is a ribosome, afloat in cell's cytoplasm. Coded slots on sphere's surface are attached RNA molecules, the "worki dies" that receive and align carrier molecules drifting





of protein—uses its needle-like "tail" to inject "working dies" into cytoplasm of victim's cells, thus multiplying self.

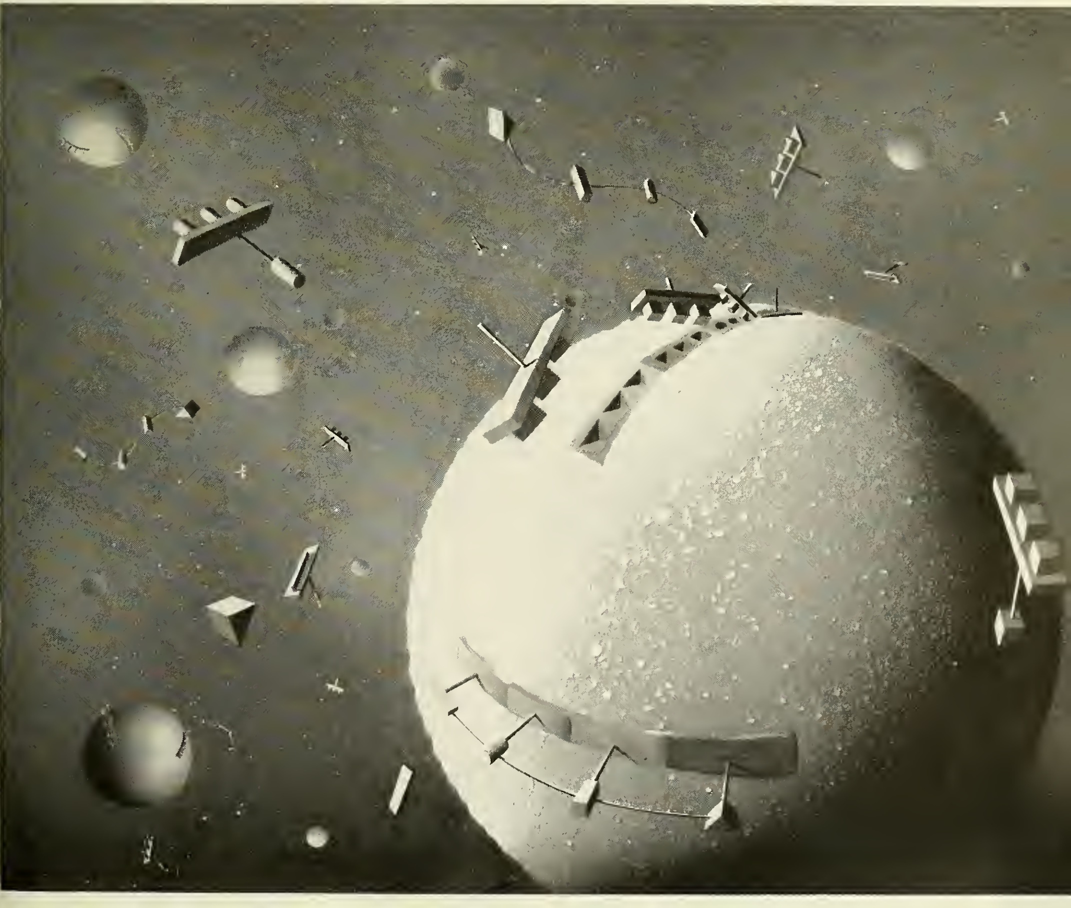
bly line" that links amino acids together into the giant molecules we know as proteins. There is still a great deal to learn about how this assembly line works, but considerable progress in understanding has been made during the past decade or so. The following account is based on experiments conducted at laboratories throughout the world and particularly on the work of Jean Brachet of the University of Brussels, of Torbjörn Caspersson of Stockholm, and of Mahlon Hoagland and his associates at the Massachusetts General Hospital in Boston. It involves numerous recent studies of the anatomy and physiology of cells.

The metabolic chores of any cell are guided, by remote control, by the DNA in its nucleus. DNA molecules may be compared to expensive master dies required to manufacture the precision parts for machinery. Such dies are too valuable to be used directly in the making of parts. The actual

cheaper, expendable working dies formed from the master dies. Similarly, DNA is too valuable to take part in the everyday business of protein synthesis and must be preserved for special duties. Locked like a treasure in the cell's nucleus, it makes "working dies" of itself—molecules of another substance, known to biochemists as ribosenucleic acid, or RNA for short.

The RNA molecules then migrate out of the nucleus. We do not know for certain how or in what form they do this, but we do know where most of them end up. With the electron microscope, we see that the region surrounding the cell's nucleus contains a tangled network of threadlike tubes, hollow vessels that are believed to serve as the cell's circulatory system. Attached to these tubes, like berries on vines, are thousands of small dense granules with diameters of from 100 to more than 150 angstroms (or some 2 to 2.5 millionths of an inch). These

Carrier molecules lock into RNA "die"—see equator of closest sphere, *below*—thus aligning the amino acid units they carry. Amino acids instantly link, forming a protein that breaks away to drift off through the fluid cytoplasm.



MR. PFEIFFER is widely known as the author of three books: *From Galaxies to Man*, *The Changing Universe*, and *The Human Brain*. This article is his first for NATURAL HISTORY magazine.

granules play a central role in our story. Known as "ribosomes," they contain eighty per cent of all RNA.

LET us take an imaginary look at the protein assembly line. Think of a single ribosome, magnified so many million times that it appears as a sphere about the size of a grapefruit. We may picture an RNA molecule, fastened securely to the surface of this sphere and containing—by way of mechanical analogy—a succession of "notches" or indentations. The working die, so to speak, is now in place.

Now, the solution in which the ribosome is constantly bathed includes large numbers of special "carrier" molecules. There are twenty different types of these molecules, and each type has attached itself to a different one of the twenty amino acid units that, in combination, make up all proteins. Each carrier type is also designed to fit into a particular notch of the RNA working die. For simplicity, our illustrations (pp. 12-13) show only four types of molecules and notches.

In the solution, the carrier molecules are moving at high speeds. They collide with one another and with the RNA working die: usually, they bounce off. But when the right molecules collide in just the right way with the right notches, they fit into place as snugly as a key in a lock and stay put. Eventually—and, in cellular terms, "eventually" may be a fraction of a second—we have the situation illustrated on the preceding pages.

What has been accomplished? As the "keys" fit their "locks," a series of amino acids, attached to their individual carrier molecules, have been put into a particular alignment. Lined up in this order, the amino acids then link to one another and separate from their carrier molecules as a completely assembled protein.

It should be emphasized that this is both a highly simplified and a highly mechanistic analogy for what is believed to be happening in protein synthesis. Proteins contain anywhere from fifty to more than ten thousand amino acids, and actual RNA working dies are correspondingly long. Furthermore, research is continuing at such a pace that our ideas about what happens will certainly be modified in the light of increased knowledge. But these schematic diagrams indicate the general picture of protein synthesis as we know it today.

The picture is a dynamic one. Every one of the thousands of proteins in the body has its specific working die, a length of RNA that occupies a key position in the amino-acid assembly line. Every second, protein molecules are being manufactured by the billion in the legions of ribosomes of tissue cells. These new molecules appear at just the right rate to replace old, broken-down molecules that have served their purposes. Life is a delicate balance between synthesis and demolition. Survival depends ultimately on the structure and function of the self-duplicating master substance in the cell nucleus—DNA molecules passed on from parents to offspring, generation after generation.

RESEARCH on the structure and the function of DNA and RNA has created a new, rapidly expanding area of biochemical genetics. It has brought a new understanding of mutation and the possibility of new treatments for hereditary diseases. But it has done a great deal more than that. The implications of current studies are so far-reaching that they concern not only the mechanisms of heredity but every major field of biology.

To cite one example, consider what happens when a virus enters the system. Certain defense cells go into action and produce antibodies that are designed to neutralize the effects of the virus. The significant point is that a unique antibody is produced for each invader. According to one estimate, the average person may be exposed to some ten thousand different kinds of infective agents during a lifetime—and in consequence manufactures some ten thousand different kinds of antibodies.

As we have already mentioned, antibodies are proteins. This means that the vast store of RNA working dies in the tissues includes a supply of special antibody dies ready for emergency use. It also means that our genetic reserves are enormous, because each working die is shaped according to the precise specifications of its DNA "master die" in the nuclei of antibody-producing cells. So an intimate connection exists between one's resistance to infection and one's ow hereditary material.

The connection goes far deepe Viruses are hereditary material on th loose; mobile genes, themselves DN or RNA molecules enclosed in prote shells. A struggle is going on in t body of a patient suffering from poli smallpox, influenza, or any other vir disease. The invading virus may ta over the genetic apparatus of an i fected cell, so that the cell no long manufactures its own proteins. Inste it manufactures hundreds or thousan of new viruses, and infection m spread swiftly. This is a war to t death, a war of competing heredita materials. The importance of und standing such processes becomes ev clearer in the light of recent work su gesting that viruses may be involv in some forms of human cancer.

In an entirely different area, nucl acids may have something to do w the highest workings of the mind. W hold enough information in our brai to fill hundreds of thousands of v umes, and investigators are specul ing about the possibility that o records of times past may be stor in the form of appropriately pattern protein molecules. If so, DNA—RN research and brain biochemistry m bring a dramatic increase in c knowledge of memory and learnin

FINALLY, biologists now believe t the development of animate fr inanimate matter may have involv DNA-like molecules. Perhaps su self-duplicating molecules, taki shape in primeval waters some th billion years ago, were the bioche cal ancestors of all modern organis Perhaps these naked genes mutat developed protective shells to beco bodies like viruses, and gradually g rise to cells—so that the great ma of evolution was under way. Ideas l these, and the accumulating body solid evidence behind them, are sig that we are on the verge of bre through along the entire front of b ogy. Basic research on this heredit material is providing the biologists today with fresh insights into fundamental nature of life itself.

ELECTRON MICROGRAPH, *right*, show number of DNA molecules, taken fr the sperm cells of the salmon. Ph made by M.I.T. Professor Cecil H is seen here at x200,000 enlargem

Carpenters of the Forest

Black woodpeckers are seen in their nest

By Heinz Sielmann

Tree platform is a precarious perch while using hammer and chisel to open rear of woodpeckers' hole twenty-two feet above ground level in beech tree.

IN THE SUMMER OF 1957, a gro
from the Institute for Films a
Pictures in Science and Educati
Munich, worked in the forests
Westphalia near Dülmen to obse
and photograph the lives of bla
green, and great spotted woodpeck
in their nesting holes. We w
anxious to locate nesting trees i
which we could cut observation p
holes and thus record the details
these birds' parental care on film.

At last, we found a black wo
pecker's hole high in a fine, hundr
year-old tree in a beech forest.
pair of woodpeckers there, we kn
from observation, were in the seco
day of incubating their eggs. With
days to go before the eggs wo
hatch, we started to build a blind—tw
ty-two feet in the air—and cut our
servation port into the tree tru
It was not until the day after
young black woodpeckers had b
hatched that our labor of cutting i
the nesting cavity was complet
Now, the observation glass had to
fitted to our hole without delay.
parent woodpeckers were so work
up by our presence that they f
boldly up to us as if they were go
to attack. After forty minutes,
glass had been fixed in place and
blind blacked out.

Now that the blind was finished
could not resist the temptation to cli
up into it and find out what could
seen. It took some time before
eyes became accustomed to the d
twilight and I could see the four sle
ing youngsters. Then I heard a wo
pecker's claws strike the tree. I har
dared breathe when the big wo
pecker poked his head into the n
for the first time. The bird's power
beak, brightly rimmed, piercing e
and fiery nape-patch were visible
only a moment. Then he withdr
frightened. This happened twice mo
Several anxious minutes went
Only later was I told that the wo
pecker had flown to a tree nea
and from there had inspected his n
tree from every angle. Ten minu
later, I again heard him climbing
the tree trunk to the entrance h
Then he gave his jackdaw-like c
The barriers were down.

The bird clambered about his d
nest with his head down. Upon ent
ing the nest, he had regurgitated so
food into his beak and he now be
to rouse the nestlings, who had he
neither his calls nor the noise

Beak flipping upward, a black woodpecker hurls wood chips from entrance of a nesting hole under construction.

Birds stop working every four to eight minutes to throw accumulated shavings from hole, which will be their home.

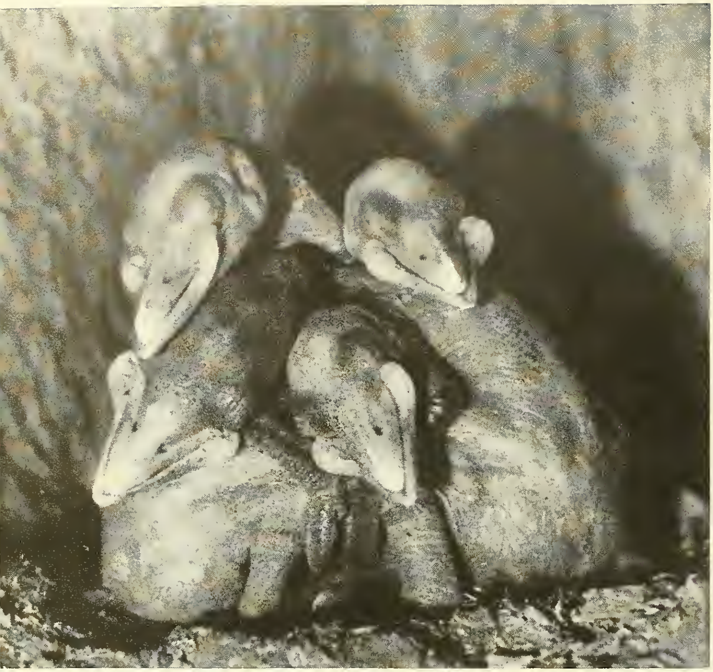
his entry. The day-old young v huddled together in a pyramid warmth and did not respond to gentle touch of his chisel-like l on their backs, necks, and wing saw that the parent bird had firs locate swellings at the sides of youngsters' beaks. At his first to on these swellings, the nestl stretched out their necks and ope their beaks wide for food.

I noticed that the nestlings several special markings, which e the parents' task of finding their l gry beaks and feeding them du these first few days. Their beaks v tipped with white and the end their tongues were brightly colo as I could see when they opened t beaks to be fed. These markings appear when the youngs' eyes open

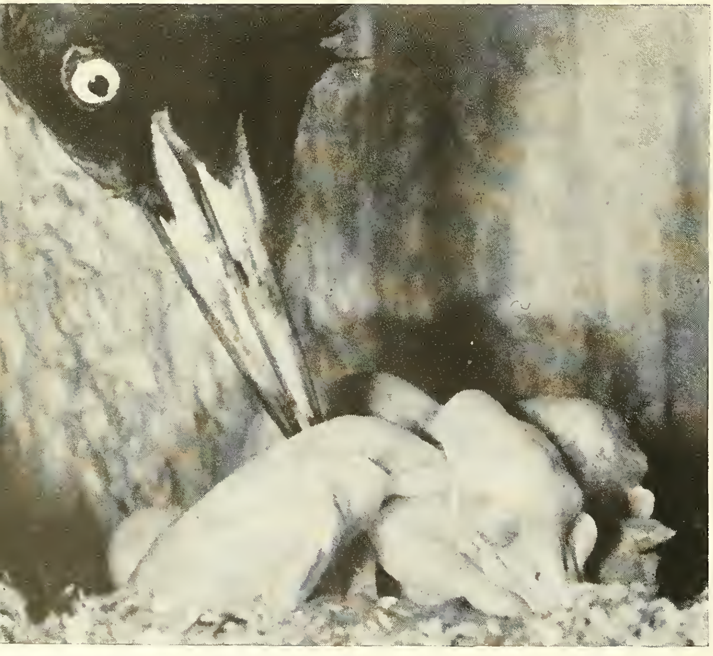
OUR male woodpecker now ro each youngster in turn and, to amazement, his beak disappeared most entirely down each bird's sk throat as he fed it. He had brough much food that he fed each of four three times over, and still some left over. The nestlings had enough, however, and did not resp further to the proffered food, so swallowed it again.

Feeding lasted three minutes. ing this time the parent bird had l hanging head down. He stayed in position some time longer while cleaned the nest. He tapped each n ling's hindquarters with his bea stimulate excretion. Then he strad the young and covered them with soft breast feathers to keep them wa He had to keep his head and stretched upwards and put his l with their fearfully sharp claws, s ways. Most of the time while he warming his brood, he kept his closed but no noise escaped his at tion. As soon as he heard the call thrush or some other small bird was wide awake and climbed up to entrance hole to see that all was v Every now and then, he tapped e youngster with his beak to see whe it needed to excrete again and t resumed his vigil.

After eighty minutes I heard hen woodpecker making her cal

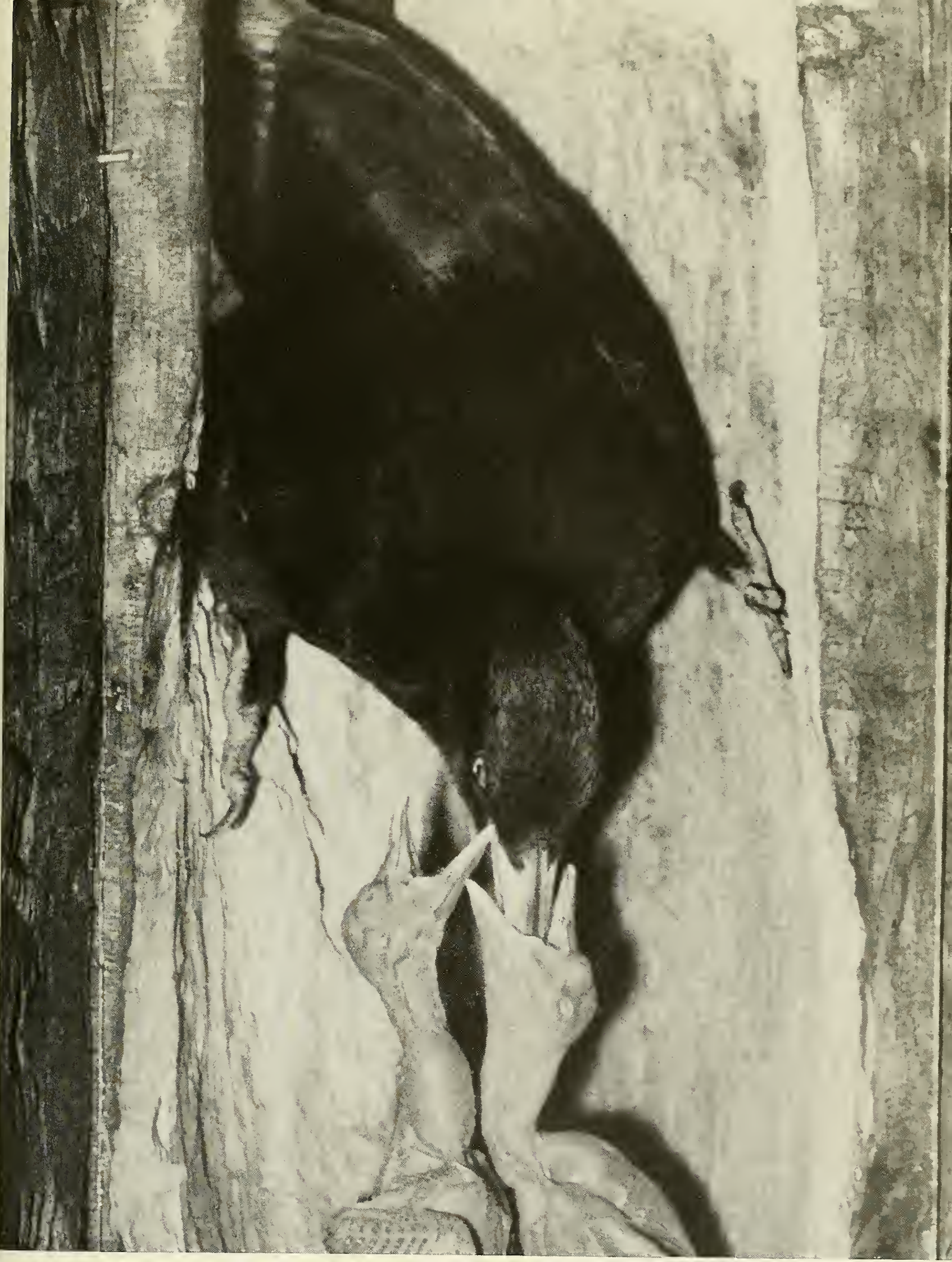


NECKS ENTWINED, young woodpeckers huddle together in a pyramid to keep warm while their parents are away from the nest. Young birds are still blind.

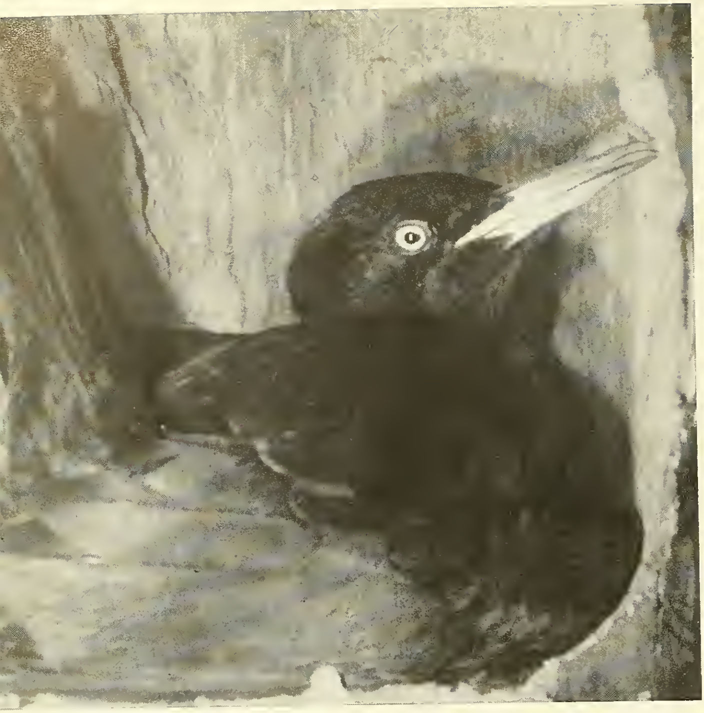


PARENTAL PROD is unheeded by young unless beak touches swelling at corner of mouth. Then young bird will raise head and open its beak to accept food.

HEINZ SIELMANN has written of h experiences filming woodpeckers his volume *Windows in the Woo* (Harper & Brothers), from which th article and photos were excerpte



Head down in its nesting hole, a male woodpecker braces claws against hole's sides as it feeds brood by thrusting beak far down youngsters' throats. Narrow, urn-shaped nest permits the woodpecker to enter and climb down head first.



SITTING WOODPECKER has to hold its tail and beak upward in nesting hole. Long tail is used as support for bird when climbing or hammering with its beak.

the distance. The male also heard her, but stayed with the young until she had come closer. Now the hen was calling from a nearby pine. The male's response was quite remarkable. The first "pee-ak" had hardly died away when he began hammering furiously at the side of the nesting hole. After several more calls from the hen the male yielded his place to her. When it was time for the hen to be relieved, seventy minutes later, she in her turn hammered three or four times on the side of the nest before making room for the male. When she returned to resume guard, there was a burst of hammering — seven strokes — followed by twelve more in rapid succession. After this, I heard a soft, cooing sound for the first time. Apparently this cooing is a sign of heightened excitement among black woodpeckers.

During the first eight days, while the nestlings' eyes were still closed, we noticed changes taking place in the feeding routine. Until they were two days old the youngsters opened their beaks only when the parent birds tapped the swelling on the sides of their heads. Taps or prods on other parts of their bodies produced no results. After the third day, whenever a youngster was fed, and consequently swung its head and stretched its neck, these movements more and more communicated themselves to the others. After the fourth or fifth day the parents needed only to offer the youngsters food for them to open their beaks. Thus, the young woodpeckers had learned that if one of them stretched out from their pyramid it meant that food had arrived. They also learned to tell when the parents had brought food by the soft snoring sound made by the youngster that was having food crammed down its gullet by the parent woodpecker.

The young woodpeckers' eyes opened on the twelfth day. They weighed six and one-half ounces, and their egg teeth and beak swellings had all but disappeared. The young birds now took up their feeding positions the moment they heard the parent birds approach. Their upper and lower bills had already grown to a length of one and a quarter inches.

After the fifteenth day, the you
birds were so big and strong that th
often jostled their parents. The ne
lings found their stay on the n
floor irksome. They wanted to try the
beaks and tongues on the sides of t
hole. After eighteen days, they beg
climbing about their nesting ho
When they were twenty days old, th
fed at the entrance to their nest.

FROM the time the young hatch
until they were twenty days o
the parent birds took turns bringi
food eight to twelve times a day. Th
fed the young every ninety minu
on the average. The first foragi
flight was usually made shortly bef
6:00 A.M.. two hours after sunri
The young were fed for the last ti
at about 8:00 P.M.

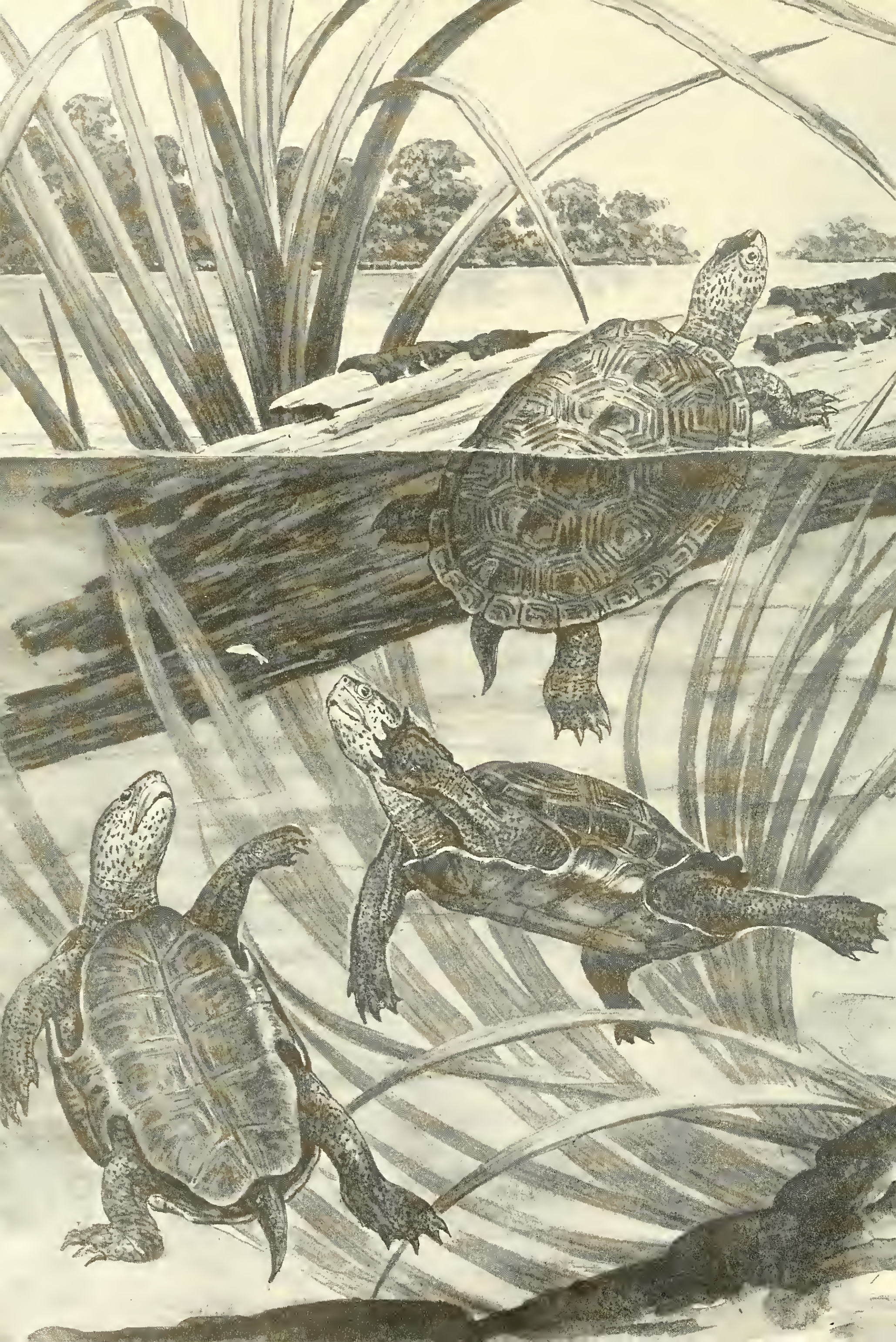
Feeding accelerated when the fle
lings were twenty days old. They w
almost grown, and their food int
had increased. On the twenty-fifth
the parent birds slackened noticea
in feeding the brood. The next day.
parents sat for hours on a branch
front of their hole and uttered t
loud "klee-ae" cry surprisingly of
That afternoon, we observed only
feeding. The fledglings became
hungry that they craned far out
the entrance hole, clamoring for f
With excited cries, the parents t
to coax the youngsters out. W
twenty-seven days old, the fledgli
dared the leap to the ground.

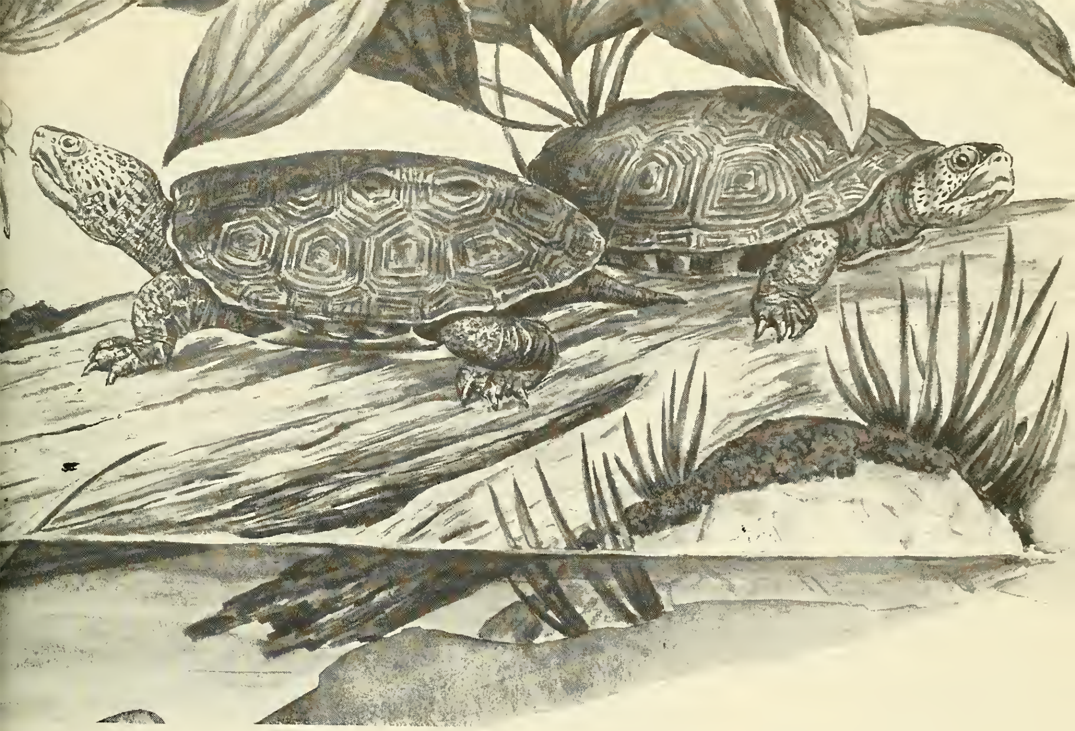
None of them returned. In all my
servations. I have never found
young woodpeckers return to t
original nest once they have lef
They will spend the first several ni
in the open and then seek out a
able new dwelling hole for themsel

GROWING YOUNGSTER tries his to
and beak on walls of his hollow h

Beak and tail of young woodpecker do not attain their full length until several months after bird has left the nest.

Woodpecker's brain resists shocks of hammering because bones connecting beak and cranium are flexibly joined.





Diamondbacks thrive in estuaries, in salt or brackish marshes, feeding upon snails, annelid worms, and small crabs.

A Turtle of Taste

Birds, beasts, and gastronomes relish the diamondback terrapin

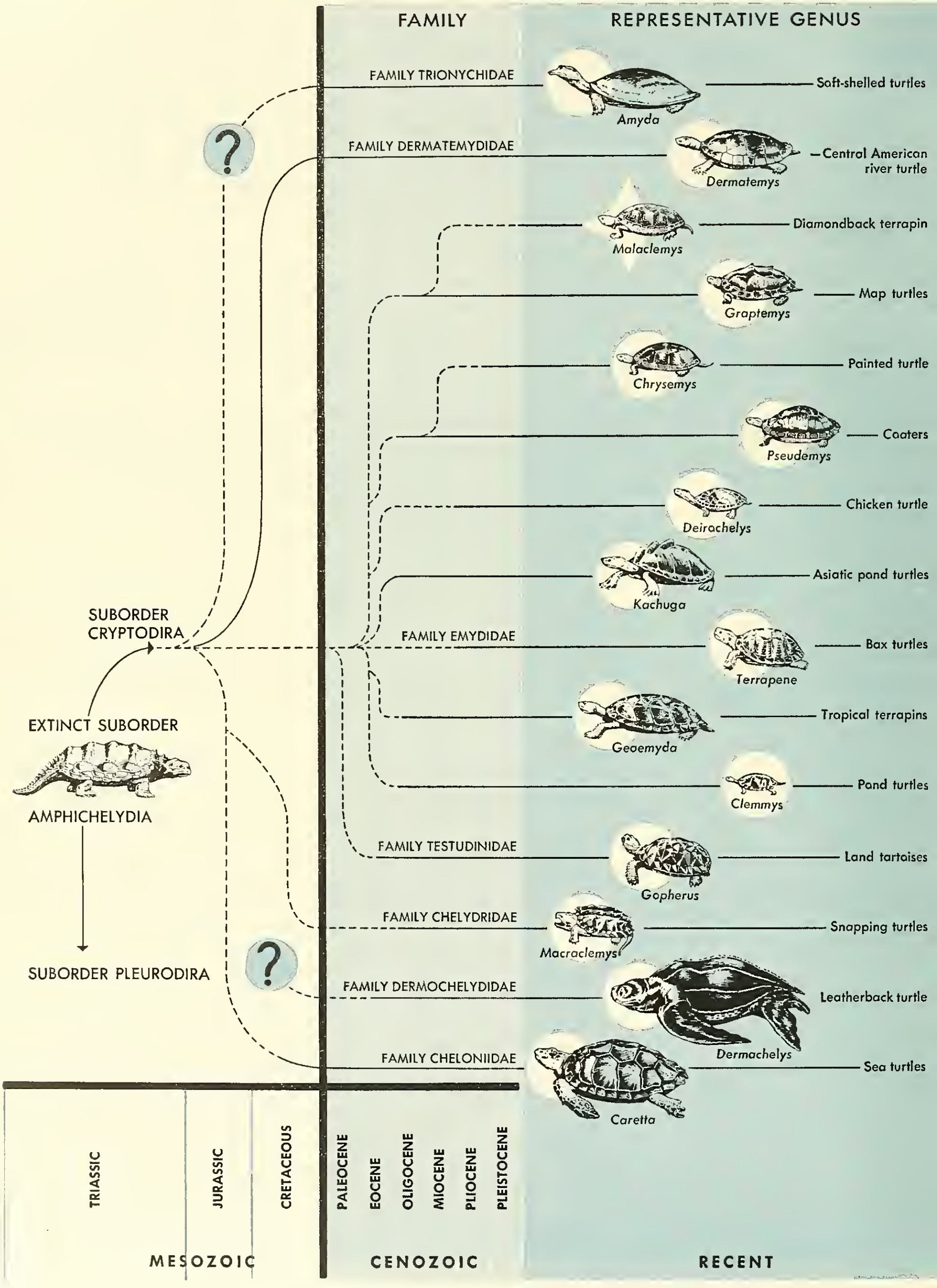
By George K. Reid

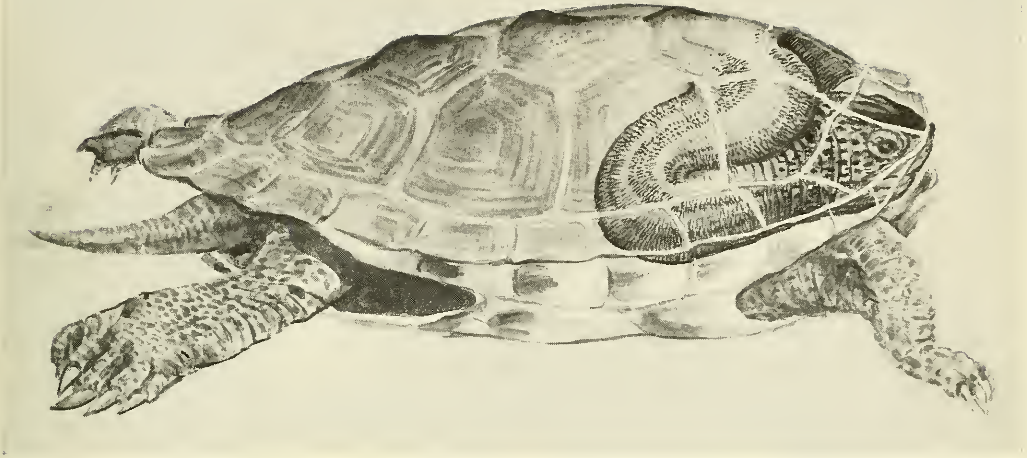
TO THE GOURMET, no reptile has ever attained the fame and esteem once held by the diamondback terrapin. From the Gay Nineties to the Roaring Twenties, diamondbacks were consumed with gusto. and at prices that stagger the imagination. As late as 1921, terrapins were reportedly selling for ninety dollars a dozen. But by the late twenties the catch began to decline and the dish's popularity to diminish. What apparently was a dietary fad passed. Despite the grandeur that was the terrapin's, and although United States government agencies had entered into a program of terrapin propagation and culture, little is known of the northern diamondback's life history in its natural state. For example, we are not sure where the young go and what they do immediately after hatching: it is thought that hatchlings hibernate at bottoms of estuaries or ponds until their second year. Because few young diamondbacks have been caught in the wild, knowledge of their natural growth rate is scant. Nor is there much knowledge about seasonal foods and feeding habits. We say tacitly that these turtles live in salt and brackish water for, to date, there have been no scientific reports of diamondbacks in fresh water. Although the U.S. Fish and Wildlife Service has studied propagating and rearing terrapins at its Beaufort, North Carolina, station, mixing of northern and southern diamondbacks in rearing pens reduces the value of studies there in terms of natural terrapin behavior and life history.

The northern diamondback terrapin (*Malaclemys terrapin terrapin*) belongs to the same family (Emydidae) of marsh and fresh-water turtles as the common box turtles (*Terrapene*), map turtles (*Graptemys*), painted turtles (*Chrysemys*), and a widespread group of turtles of the genus *Pseudemys*. Brightly colored young of the last two groups are often sold as pets in novelty stores.

The reptilian order Chelonia is made up of a varied and exciting array of scaled, egg-laying animals whose body temperature is generally that of the immediate environment.

CRYPTODIRAN TURTLES—SELECTIVE "FAMILY TREE"


FAMILY
REPRESENTATIVE GENUS
FAMILY TRIONYCHIDAE
Amyda
Soft-shelled turtles
FAMILY DERMATEMYDIDAE
Dermatemys
Central American river turtle
Malaclemys
Diamondback terrapin
Graptemys
Map turtles
Chrysemys
Painted turtle
Pseudemys
Cooters
Deirochelys
Chicken turtle
Kachuga
Asiatic pond turtles
FAMILY EMYDIDAE
Terrapene
Box turtles
Geoemyda
Tropical terrapins
Clemmys
Pond turtles
FAMILY TESTUDINIDAE
Gopherus
Land tortoises
FAMILY CHELYDRIDAE
Macroclemys
Snapping turtles
FAMILY DERMOCHELYDIDAE
Dermochelys
Leatherback turtle
FAMILY CHELONIIDAE
Caretta
Sea turtles
?
?
SUBORDER CRYPTODIRA
EXTINCT SUBORDER
AMPHICHELYDIA
SUBORDER PLEURODIRA
TRIASSIC
JURASSIC
CRETACEOUS
PALEOCENE
EOCENE
OLIGOCENE
MIOCENE
PLIOCENE
PLEISTOCENE
MESOZOIC
CENOZOIC
RECENT



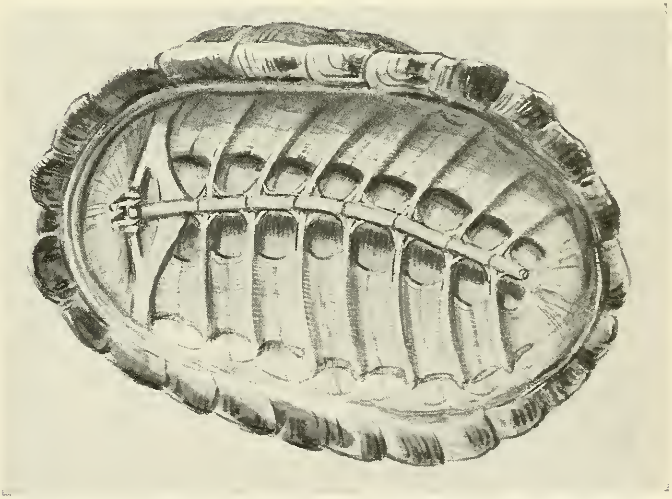
Distinguishing feature of diamondback terrapin is its way of bending its neck in a vertical plane when retracting head within shell. Diamondbacks belong to a turtle family whose members are found throughout the world except Australia.

Living turtles are divided into two suborders, the Pleurodira and the Cryptodira. The former live only in the Southern Hemisphere today, and are known as "side-neck" turtles because they bend the neck laterally when withdrawing head into shell.

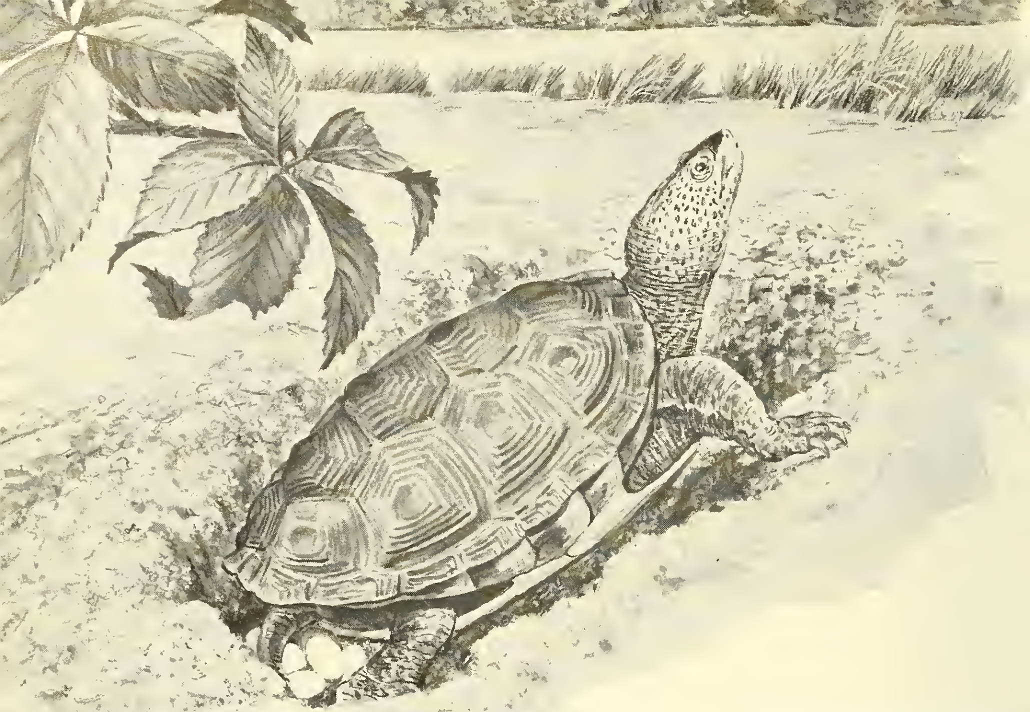
Members of the Emydidae, like other cryptodirans, bend the neck vertically in retracting the head. The emydids are different from other related families (see chart) in essentially lacking a roof over the head's temporal region, and in having three-jointed middle digits. The plastron, or lower shell, is made up of twelve bony shields with a bony connection to the upper shell, or carapace. The skin on the upper surface of the head is not broken into furrowed patterns. The front feet have five claws and the rear have three or four, usually with some webbing between claws. This family of turtles, the largest, is widely distributed over the earth —in fact, Australia is the only continent where no member of the group is found.

Diamondback terrapins (*Malaclemys terrapin*) are found only in North America, and six subspecies occur in coastal marshes and brackish waters from New England along the Atlantic coast to Florida, and westward through coastal areas of the Gulf states and Mexico. These subspecies, or races, occupy certain geographical limits, and within their ranges are generally differentiated by form and structure. However, at extremes of ranges, where distributions overlap, subspecies apparently interbreed and their characteristics blend. This phenomenon, referred to as "intergrading," results in individuals not referable to either subspecies involved. since intergrades are usually intermediate between two subspecies. Between zones of overlap, animals may be recognized by their characteristics and may be named accordingly.

Northern diamondback terrapins (*Malaclemys terrapin terrapin*), the subspecies with which we are concerned here, are found from Cape Cod southward to the Cape Hatteras area. In the southern portion of its range,



Diamondback carapace gives a clue to whether it belongs to northern or southern subspecies. Northern turtle's shell is more narrow toward the front.



Female diamondback deposits egg nest she has dug with hind feet. A eggs are laid, female fills in the ı moving back and forth to smooth ea

the northern diamondback intergrades with its southern counterpart, *Malaclemys terrapin centrata*. Differences between them are slight, the best distinguishing characteristic being the shell's shape. That of the northern diamondback is rather wedge-shaped and narrowed toward the front, while the shell sides of the southern subspecies are nearly parallel. The southern diamondback ranges to the southern tip of Florida, where it intergrades with the mangrove terrapin (*Malaclemys terrapin rhizophorarum*), the latter being recognizable by bulbous keels on the carapace's central plates and by the absence of light-colored centers on carapace plates. Adjoining the mangrove terrapin and ranging from the lower Gulf coast of Florida to near Pensacola, the Florida diamondback is quickly recognized by bright yellow or orange centers in each plate of the carapace.

The Mississippi terrapin (*Malaclemys terrapin pileata*) inhabits the Gulf coast from eastern Louisiana to western Florida. This subspecies has a very knobby keel on the carapace and is evenly brown or black in color, including the top of the head. In eastern Louisiana, the Mississippi terrapin intergrades with the Texas diamondback (*Malaclemys terrapin littoralis*), the latter ranging southward along the coast of Mexico. This last subspecies is uniformly dark-colored on the carapace, but the top of the head is usually white.

Habits of the northern terrapin in its environment are fairly characteristic of all terrapins. It inhabits salt creeks and estuaries, and even open seas. Although terrapins are primarily aquatic, they have been known to make long treks on l Females, in particular, may travel over dry ground to find a nesting Copulation occurs in the water be the female begins her nesting mi tion. Indeed, there is evidence one copulation may supply enc fertilized eggs to last the femal long as four years. As is the case many animals, there is a great size parity between sexes of the diam back. Females may grow to ne ten inches in length, while m never become much longer than or possibly six inches at most.

These turtles are omnivorous f ers, and eat crustaceans and moll and scavenge on nearly anything atable. They may also eat m plants. Captive diamondbacks are raw fish. When cold weather n diamondbacks hibernate in mu the bottom of watercourses. may leave their hibernacula du warm spells, but return to spend harsher part of the winter.

Formerly of Rutgers University, Dr. Reid is Senior Professor of Biology at Florida Presbyterian College in St. Petersburg. He has specialized in marine ecology and in ichthyology.

During the summer of 1953, I was studying the social organization and movements of the periwinkle (*Litorina*) in marshes of the York River in Virginia. One June morning, as I started toward the study area. I saw a female diamondback poised on the edge of her newly dug nest, depositing eggs. Here was a chance to watch an event seldom seen among "wild" terrapins but that had been observed often among captive animals. I returned to my car for a camera, then approached the terrapin cautiously. She obliged briefly while I photographed her, but then began to move away toward a nearby stream. Attempts to persuade her to finish her task failed, so I examined the nest.

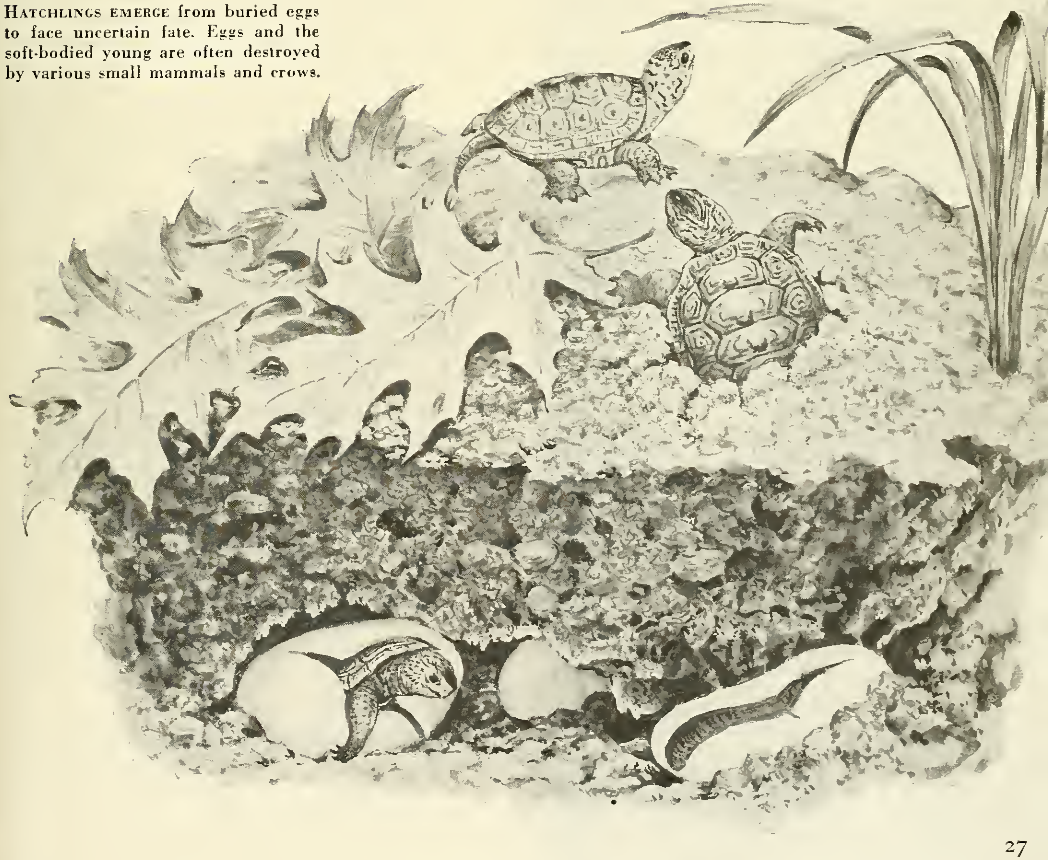
THE nest site was near Yorktown, where diamondbacks had lived for many thousands of years before the settling of the historic site of Cornwallis' surrender. The nest had been dug in sand and shell material that had been used for filling a marsh area for highway and park construction. It was about sixty feet from a tidal creek that joined the nearby York River. The hole in which the eggs were being laid was roughly triangular, about four inches across and six or seven inches deep. Seven eggs had been laid: they were elongate and ovoid, slightly more than an inch long and less than an inch thick.

The eggs were removed from the nest, placed in a basket containing some of the surrounding sand, and taken to my home. There, the sand was kept moist and the basket was placed in the kitchen under the watchful though somewhat skeptical gaze of my wife.

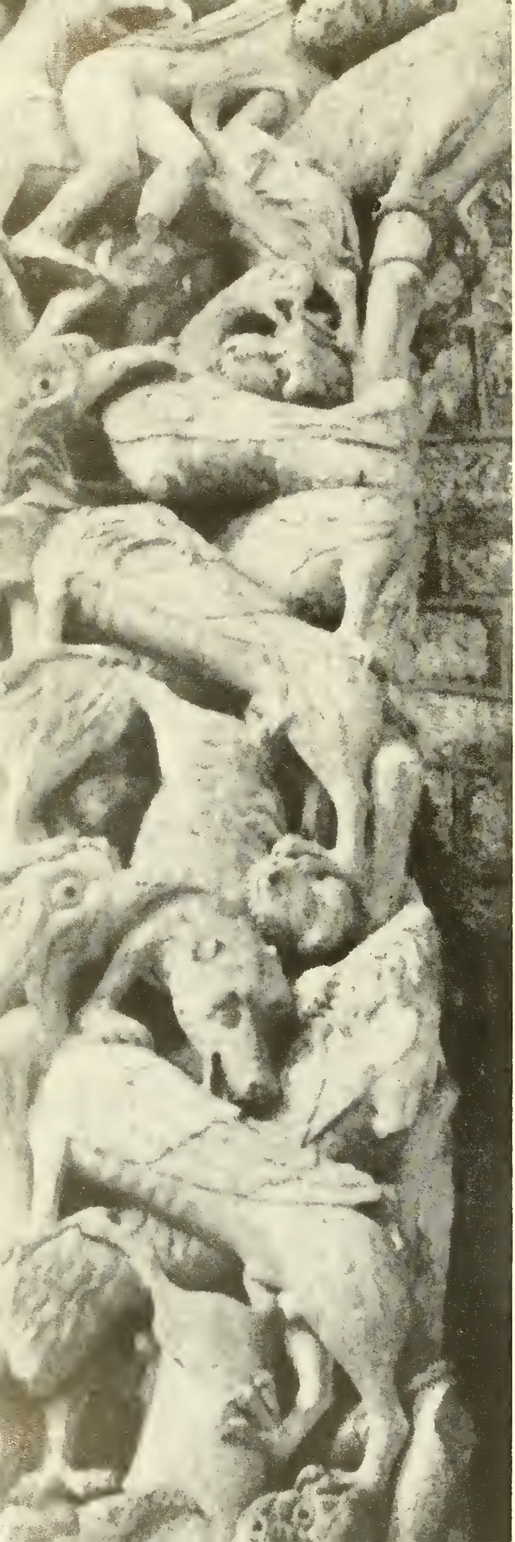
On a Sunday, sixty-nine days from the time the eggs were laid, I returned home from a trip to the marsh and my wife announced that a terrapin hatchling had fallen from the table onto her foot. A search of the sand revealed that the other eggs were also in the process of hatching.

DIAMONDBACK hatchlings are quite brightly marked on both upper and lower shell surfaces. The markings become duller with age. When a baby terrapin leaves the egg, its carapace is about an inch and a quarter in length and three-quarters of an inch wide. It probably takes seven years for the diamondback terrapins to grow to the stage of sexual maturity.

Although the once abundant northern diamondback terrapins declined in numbers, there are indications that the population is now increasing. Various states protect the reptiles, limiting the taking of diamondbacks to certain seasons, and restricting sizes that may be caught for market.



HATCHLINGS EMERGE from buried eggs to face uncertain fate. Eggs and the soft-bodied young are often destroyed by various small mammals and crows.



ANIMALS AND

Weird Romanesque beast

TO BEHOLD THE ANIMAL WORLD through th looking glass of Romanesque sculpture to be transported to a twelfth-century realm strange paradoxes and entrancing marve Certainly medieval art deals primarily wi Christian themes, presenting religious narr tive, dogma, and the like through human figure Special areas of the architectural framewo of every church in the Romanesque peri had become established carriers of sculptur imagery whose purpose was didactic—setti forth scripture, history, doctrine, and ethics the worshipers. The principal parts thus em ployed included the great space under t entrance arch (the "tympanum"); the post (t *trumeau*), which divided the portal at the ce ter while supporting the tympanum; the interi and exterior capitals, and those of the cloist

In Romanesque art, animals achieved t highest degree of sculptural prominence th they were to have in all the medieval peri sharing the favored locations in the church almost equal terms with the figured represent tions, human and divine. Herein lies one par dox for, while the sense of the figured subje is fairly explicit, that of the animal carvings co ceals its mystery from us more often than n Scholarly opinion ranges from those who pr fess to find symbolic meaning in all the animal imageries to those who find most them to be products of arbitrary inventio Neither extreme has been satisfactorily demo strated and the search for the truth is st actively pursued.

One would think that the monumental *tr meau*—conspicuous as it must be at the cent of the main portal, and compositionally bou

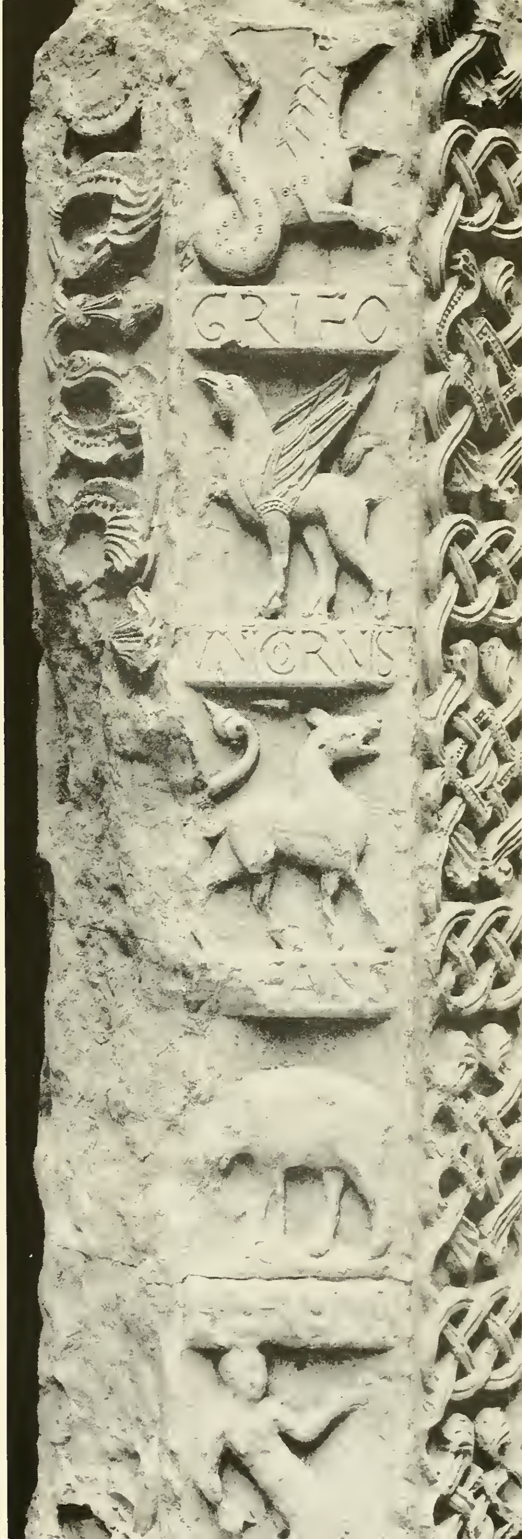
Fantastic hybrid beasts in pairs form cross pattern on *trumeau* of abbey church at Souillac. Monsters attac from top down, a man, a bird, a dog, a stag.

OF FACT FANCY

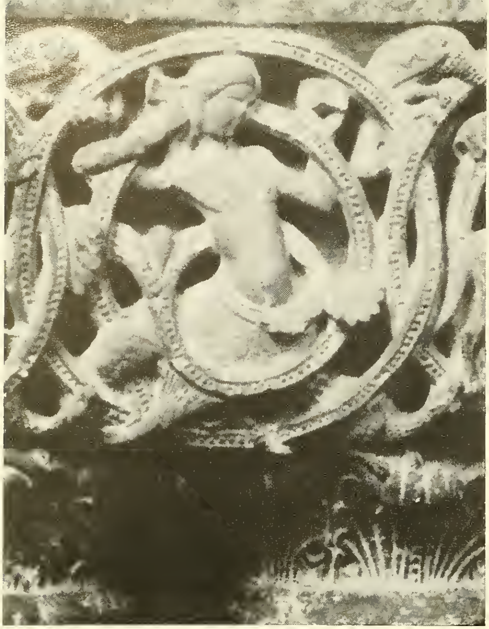
challenge the imagination

to the tympanum and jamb sculptures—would yield the key to the reading of its animal carvings. But this has not yet happened. The most famous of all, the *trumeau* of the abbey church at Souillac, *left,* presents an amazing tangle of such indecipherable beasts. Hybrid, winged quadrupeds with bird or beast heads, arranged in crossed pairs above each other, weave in and out of a framing trellis, twisting backwards, biting and clawing a series of animal victims, suspended helplessly on the middle axis of the shaft. It seems hardly credible that the sculptor would have been given complete freedom to invent, at will, the subject to be displayed on so large a scale at the church entrance.

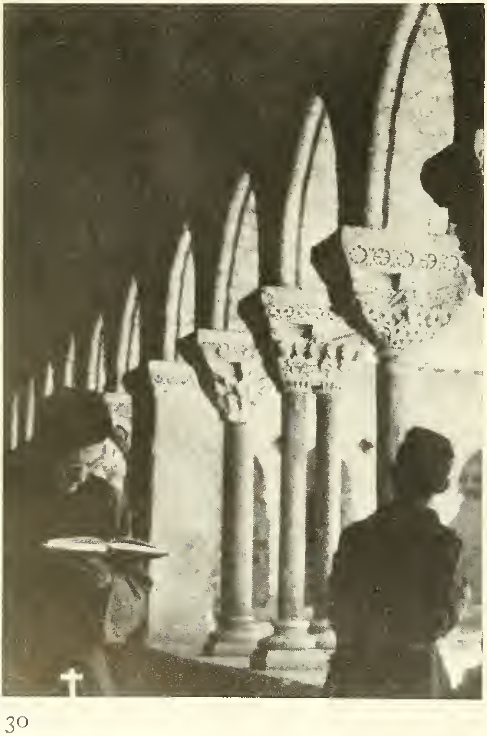
In the virtually complete absence of external evidence for any interpretation at all, we must isolate whatever may be discovered of the essential ideas contained within the work itself. The theme is plainly that of violent struggle between two different animal kinds. There are the monstrous beasts and there are their victims. The former are chaotically entangled grotesques for which no names can be found. The latter are visibly differentiated from each other and their aggressors, and are depicted as recognizable animals based on a natural order in creation. The progression begins with a frog-like reptilian at the bottom (not visible here), continuing with a wild animal (of unknown species), a canine, a bird, and finally, a man. Is there, in this drama, an epic of the struggle between the creatures of the orderly world and the inchoate forces of brute darkness and evil, or is it, instead, a sort of a warning or threat held up to man, as the ruler of the animals?



Bestiary creatures decorate one face of octagonal pier in church at Souvigny. In descending order are seen hippocamp, griffin, unicorn, elephant, siren.



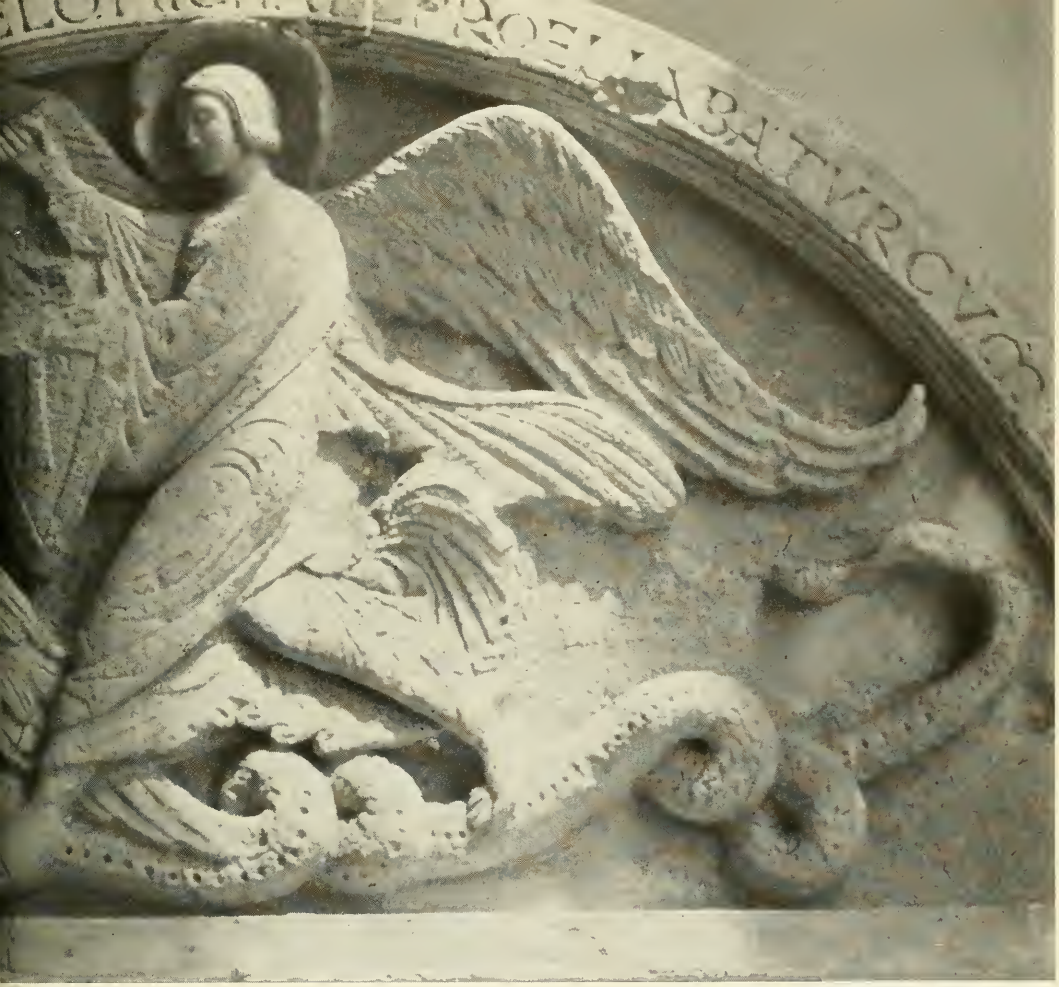
Siren, *above*, together with centaur and harpy, was carried into medieval art from classical antiquity. This figure is on capital from La Daurade, Toulouse.



Cloister passage of the church of Saint-Pierre, at Moissac, displays capitals of three types—those devote to religious subjects, to animals, and to foliage.

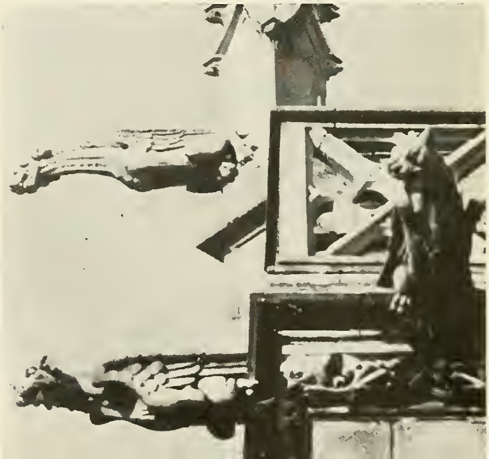
T PROELIVMMIN

If no other monuments afford us helpful light on such questions, they do yield further animal epics of tantalizing brilliance. Among these, the *trumeau* of the church at Moissac (see cover) stands supreme, with its succession of paired lions and lionesses chiastically punctuating the shaft as if in some bizarre heraldry. It might seem an easy matter to apply to the Moissac *trumeau* one of the many known meanings of lions in the Middle Ages. Among the real and nonexistent beasts described in the bestiaries,



Winged dragon is slain by St. Michael's lance. This struggle between good and evil is after a cast of the tympanum of church of Saint-Michel-d'Entraigues.

illustrated in the manuscripts, and carried into monumental sculpture, the lion stands first. He is identified with Christ, "the Spiritual Lion of Judah," and is interpreted to symbolize the Resurrection. But in other contexts the lion may symbolize evil over which Christ is triumphant. The style of the Moissac lions must be termed abstract, despite their recognizable derivation from nature. And here, from the point of view of style, is another Romanesque paradox—the actual becomes abstract while the nonexistent



Gargoyles, such as these at Limoges, are carved water spouts of the Middle Ages, although the term has been incorrectly used to describe chimeras on Notre-Dame.

may become real. For all their overpowering sense of reality, the conventionalized modes of Romanesque stylization transform the contours, hair, flesh, and sinew of the lions away from natural appearance toward abstraction. Their force and vitality come from the fact that the sculptor, through line, shape, and pattern, has been able to distill the most essential qualities of surface, volume, and action of the lion, rather than attempting to duplicate its more obvious naturalistic appearance.

Thus, too, the unreal monsters of the Souillac *trumeau* partake of the same quality of reality, despite their hybrid components. In this instance, flesh, feathers, horns, scales and bone, which would have been conspicuously disparate and incongruous in an illusionistic style, have become all of one stuff—stylized and abstracted to the same degree throughout. In place of an implausible bogey, the sculptor's creature assumes an awful, if bizarre, visual reality.

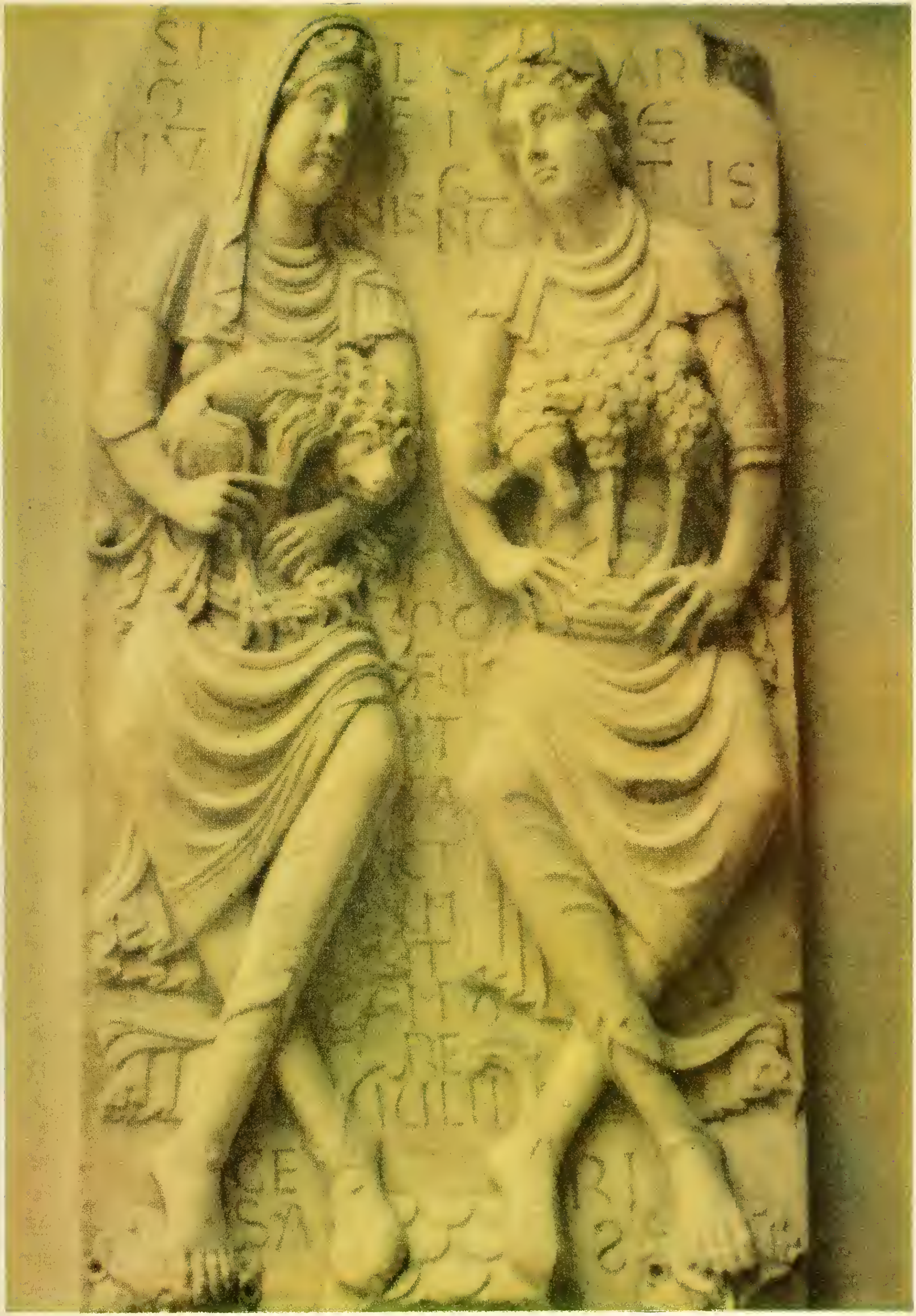
The weight of evidence against finding symbolic and other calculated meanings in these representations is based mainly on the text of a letter written by a competent witness during the first quarter of the twelfth century, just after these sculptures were carved. This was St. Bernard of Clairvaux, criticizing extravagant display and decoration in churches that he had just visited. He referred specifically to the sculptured capitals in the cloisters: "But in the cloister, under the eyes of the Brethren who read there, what profit is there in those ridiculous monsters, in that marvellous and deformed comeliness, that comely deformity? To what purpose are those unclean apes, those fierce lions, those monstrous centaurs, those half-men, those striped tigers, those fighting knights, those hunters winding their horns? Many bodies are seen under one head, or again, many heads to a single body. Here is a four-footed beast with a serpent's tail; there a fish with a beast's head. Here again the forepart of a horse trails half a goat behind it, or a horned beast bears the hinder quarters of a horse. In short, so many and so marvellous are the varieties of divers shapes on every hand, that we are more tempted to read in the marble than in our books, and to spend the whole day in wondering at these things rather than in meditating the law of God. For God's sake, if men are not ashamed at these follies, why at least do they not shrink from the expense?" [written *circa* A.D. 1125.]

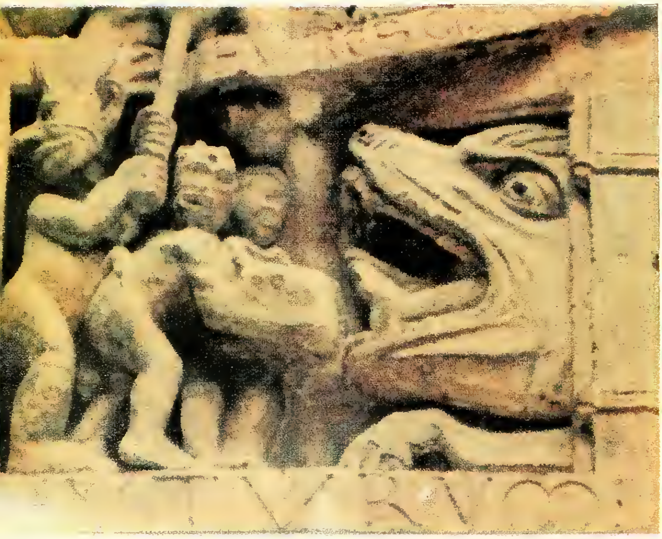
For this study of animal iconography, the editors are indebted to the guidance and co-operation given by DR. HARRY BOBER, Associate Professor at the Institute of Fine Arts, New York University. Dr. Bober is a distinguished medievalist whose work is internationally recognized. HANS GUGGENHEIM, who executed the cover, also spent many weeks in France photographing the Romanesque animals that illustrate this special NATURAL HISTORY article.

Between the lines of St. Bernard's tirade one may read a sensitive and profound sympathy for these very sculptures and their kinds and forms could not be more succinctly characterized than in this denunciation. Their rejection, so far as symbolic possibilities are concerned, would appear to be categoric and comprehensive. Still, we need not resort to the view that these stone beasts are nothing but "follies." St. Bernard's position could not have been a common one or it would not have required such painstaking vehemence. No doubt there existed a vast and unforgettable lore of animal symbolism, not only in the bestiaries—which continued to be copied and illustrated to the end of the Middle Ages—but also in scriptural allusions and metaphors, especially in the Psalms, and in the terrifyingly vivid creatures of the Apocalypse.

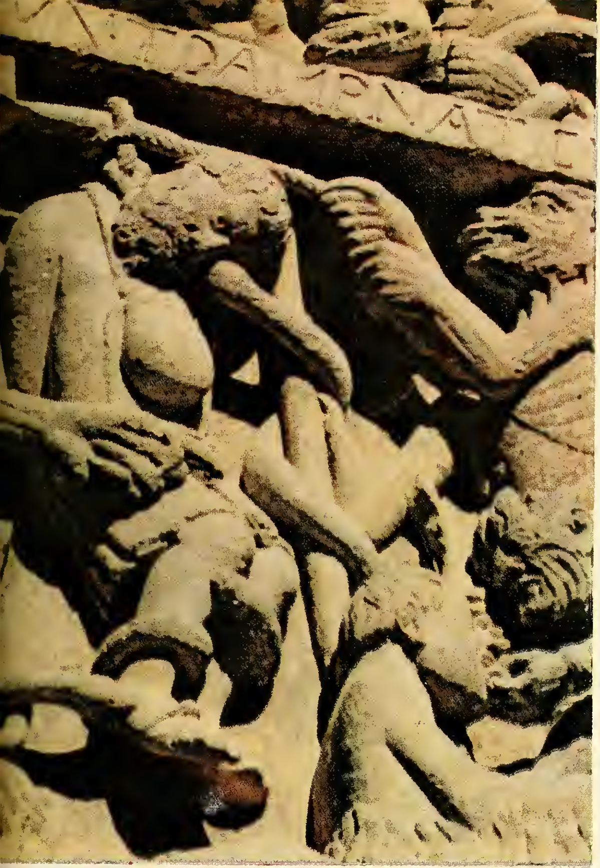
If the hybrid sirens and centaurs of classical mythology were most systematically preserved in the bestiaries, they were also carried in the living tradition of folklore, where they retained the bewitching taint of paganism with its reprehensible connotations. The fishtailed siren was then, as it remains today, the universal symbol of man's entrapment through sensuous delusion. Indeed, in the cardinal medieval antithesis between good and evil, deformed reptilian creatures are to be discovered everywhere in contexts that leave no room for doubt as to their sinister meaning. The type may be shown in the guise of a particular virtue, contrasted with its relevant vice. This is epitomized in the sculptures of the archangel Michael defeating the demonic dragon (pp. 30-31, *top*), taken to signify both the struggle between the forces of good and evil and the ultimate triumph of the heavenly hosts over the fallen angels and Satan.

The lion and ram, zodiacal beasts also relating
Christ as the King and the Lamb, are from cast of marl
piece in church of Saint-Sernin, Toulou



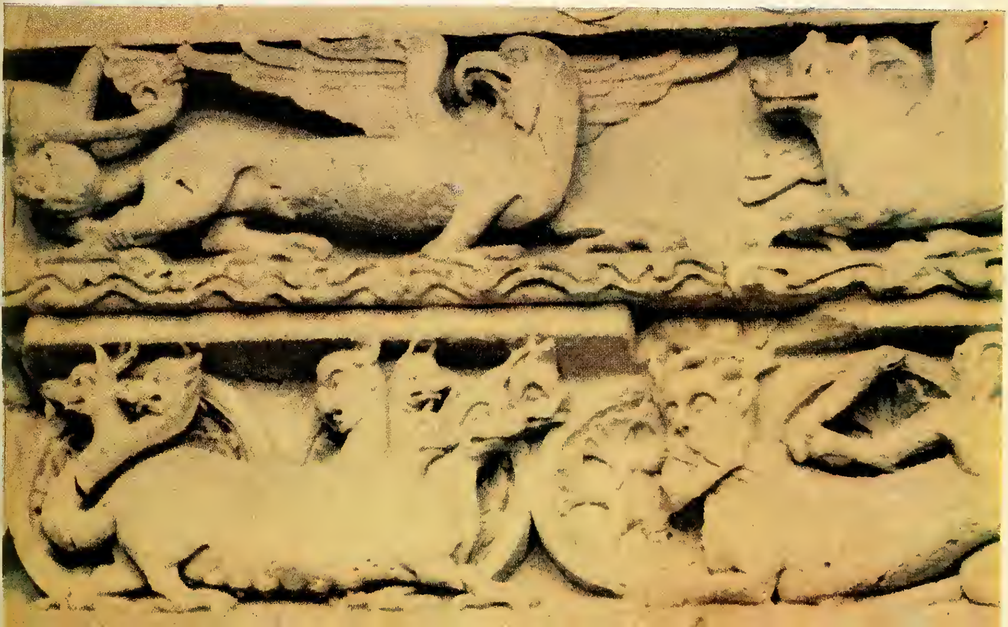


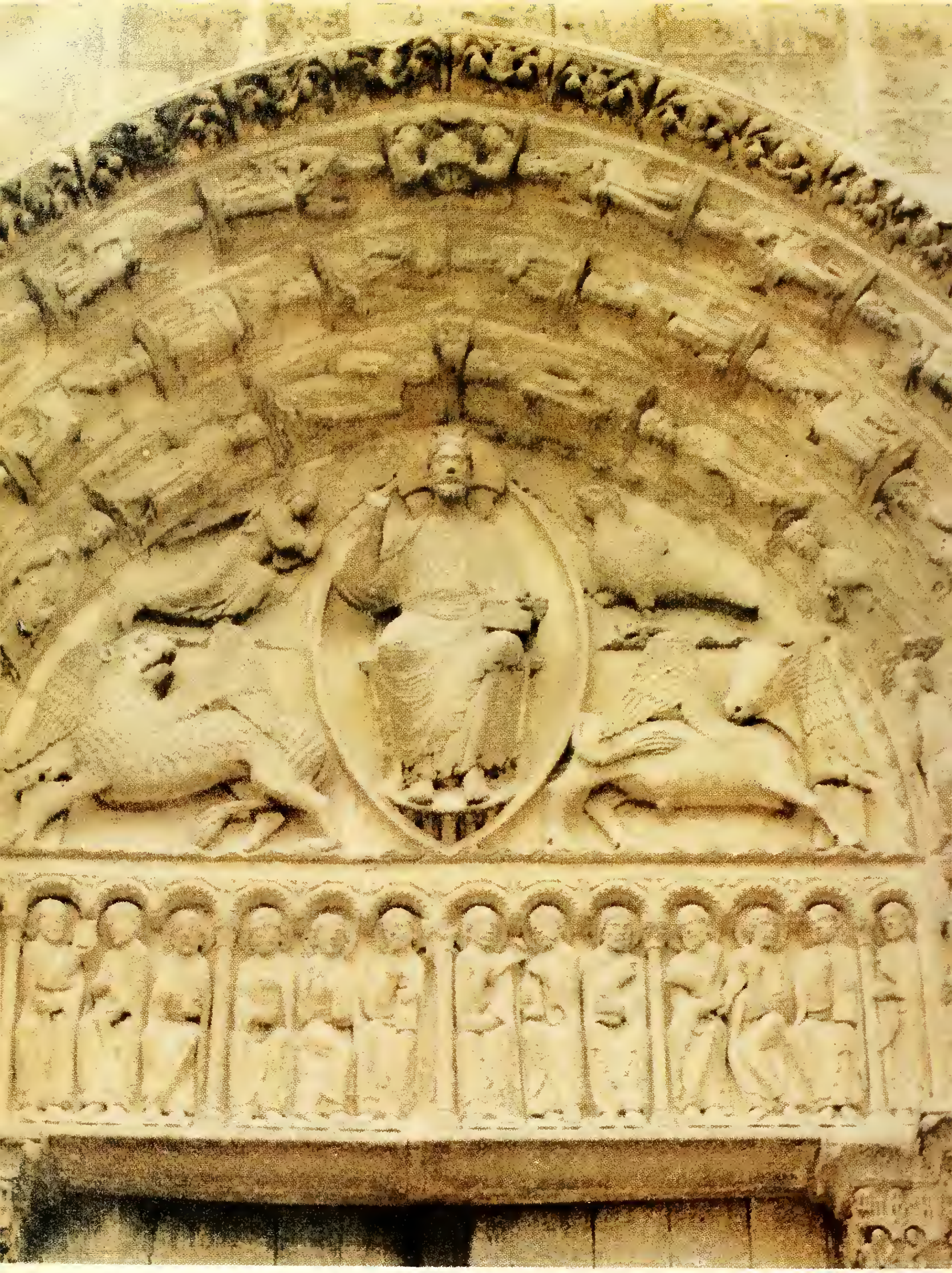
Hell Mouth's gaping jaws await damned prodded forward by weapon-wielding de at left. Like many beasts of the period, monster is a hybrid and unidentifiable. Detail is from tympanum of west portal, church of Sainte-Foy at Conques.



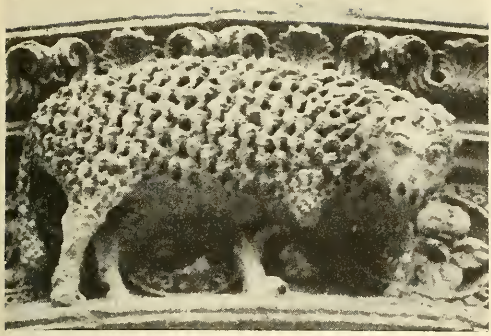
Snake-entwined Prince of Darkness rules Hell, surrounded by damned and beastlike demons. At left, pride tumbles as knight falls from horse, and lovers are roped together. At right, miser's moneybag hangs from his neck. This is also on church at Conques.

Fanciful creatures adorn lintels of abbey church at Beaulieu, *below*. In top panel is lion-bodied, eagle-headed, winged griffin. In lower panel is seven-headed apocalyptic beast representing antichrist (or Rome). To its right is human-headed dragon.





The angel, symbolical of Matthew, the winged lion of Mark,
the winged ox of Luke, and the eagle of John
surround Christ in Majesty on cathedral of Chartres.



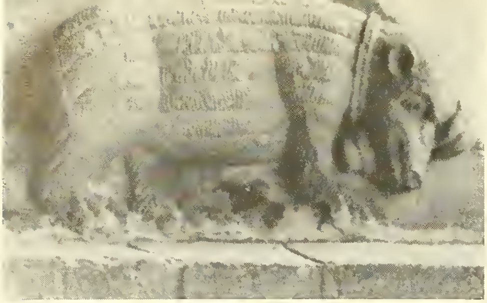
Lamb, a detail of carvings over main portal of Cahors, probably has a religious symbolism, but is also a realistic study of an economically important animal.

Considering what has been said about the peculiar capacity of Romanesque abstraction for giving convincing visual shape to the fantastic, it may be expected that the real heyday of monstrous animal sculptures comes to a close with the dawning of Gothic art—in the second half of the thirteenth century and thereafter to the end of the Middle Ages. The Gothic sculptor, with the things of the actual world for his models, could find little place for the strange beasts born of Romanesque invention. But these beasts never disappeared entirely: we find them as a contrasting marginal counterpoint to the main scenes of illuminated manuscripts, in the famous *drôleries* of Gothic miniatures, and in the periphery of architectural sculpture. Thus, as a bizarre foil to the smiling angels and saints of the portal sculptures, the glowering demons are made to mask the waterspouts and are silhouetted against the sky as the familiar, spectral gargoyles. Of these, indeed, it may be most truly said that they are whimsical and undecipherable "follies"—*drôleries* in stone.

Curiously enough, it is in an area of science that one special class of imagined animals becomes fixed, namely, in the constellations of the zodiac. Among the twelve signs in that imaginary belt of the heavens, seven were named for beasts, natural or mythical. The tradition by which man comprehended groups of stars by superimposing such imaginary figures is common to all the major historical cultures since the days of ancient Babylonia. While the animal symbols assumed definite, fixed forms in the illustrations of medieval books, they often took remarkably unrecognizable shapes when they emerged in Romanesque sculpture. But the permutations of single signs are of less interest, in this context, than is the use to which the cycles were put in the planning of sculptural programs. In the majestic tympanum of La Madeleine in Vézelay, the main subject—which presents Christ giving the mission to his apostles—is framed by a series of medallions that include the zodiacal signs alternating with little scenes of the activities of the months. The signs therewith provide the symbolic orientation for the central dogma, setting Christ in the heavens that embrace the widest dimensions of cosmic creation. Again, one of the faces of the octagonal pier at Souvigny shows the twelve signs. Taken together with another face, depicting the activities of the months, and one showing the animals of the bestiary, the pier may be said to comprise a symbolic compendium of natural history; the heavens (zodiac), earthly time and the seasons (occupations of the months), and the earth's animals (the bestiary).

Unique among Romanesque sculptures of zodiacal animals is an isolated marble relief slab, now in the Toulouse museum but originally part of the city's church of Saint-Sernin. It shows two seated women, each with one foot shod and the other inexplicably bare (p. 33). Each holds an animal on her lap—one a lion and the other a ram. The mystery would be complete were it not for an inscription: SIGNUM LEONIS, SIGNUM ARIETIS, HOC FUIT FACTUM T(OLOSAE) TEMPORE IULII CAESARIS. These are, then, surely the zodiacal lion and ram, and refer to an event said to have happened in the time of Caesar. The allusion derives from dim local legend that tells of two women who, in

Dolphin is cryptographic representation of Christ as ichthys, the fish—a symbol with many interpretations. This Coptic sculpture is now displayed in the Louvre.



One of a sequence of nonnative but realistic beasts, this bear adorns portal of church at Carennac. Collar indicates sculptor may have used tame bear as model.

Eagle capital crowned with stalking lion, *above*, is at Saint-Gilles-du-Gard. Animals, *below*, at Saint-Pierre. Aulnay, are clearly labeled: "These are elephants."

those days, gave miraculous birth at Toulouse —one to a lion and the other to a lamb. Both animals are frequently symbolic of Christ. But it is a question how, and even whether, such meanings may be properly connected with the zodiac. It may be that the same old tradition that gave birth to the legend also preserved something of the early teachings of the Church. In the fourth century, when the Church fathers were making new converts among adult pagans. who were already steeped in dubious zodiacal superstition, it was sometimes thought easier to substitute a new Christian interpretation for the zodiac than to attempt to dislodge the old. Thus, in one early sermon to neophytes, St. Zeno explained that the converts were "reborn in baptism" under new signs—that Aries was replaced by the Lamb of God, that Leo signified His strength, and so on for all the constellations.

In early Christianity, animal symbols were widely used, the fish being especially favored among those that stood for Christ. Its adoption was partly based on the pagan belief that dolphins actually saved shipwrecked sailors. The Christ fish emblem is generally identifiable as a dolphin (p. 37), and its reference is to salvation. More than that, when it was noticed that the first letters of the Greek for "Jesus Christ, of God, the Son, Saviour" formed an acrostic of the word for fish, "ichthys," the symbol became identified with the very person of Christ. Nevertheless, the idea at the core of this animal symbolism was salvation, reiterated in other subjects, including Jonah, Daniel. and Christ as the Good Shepherd.

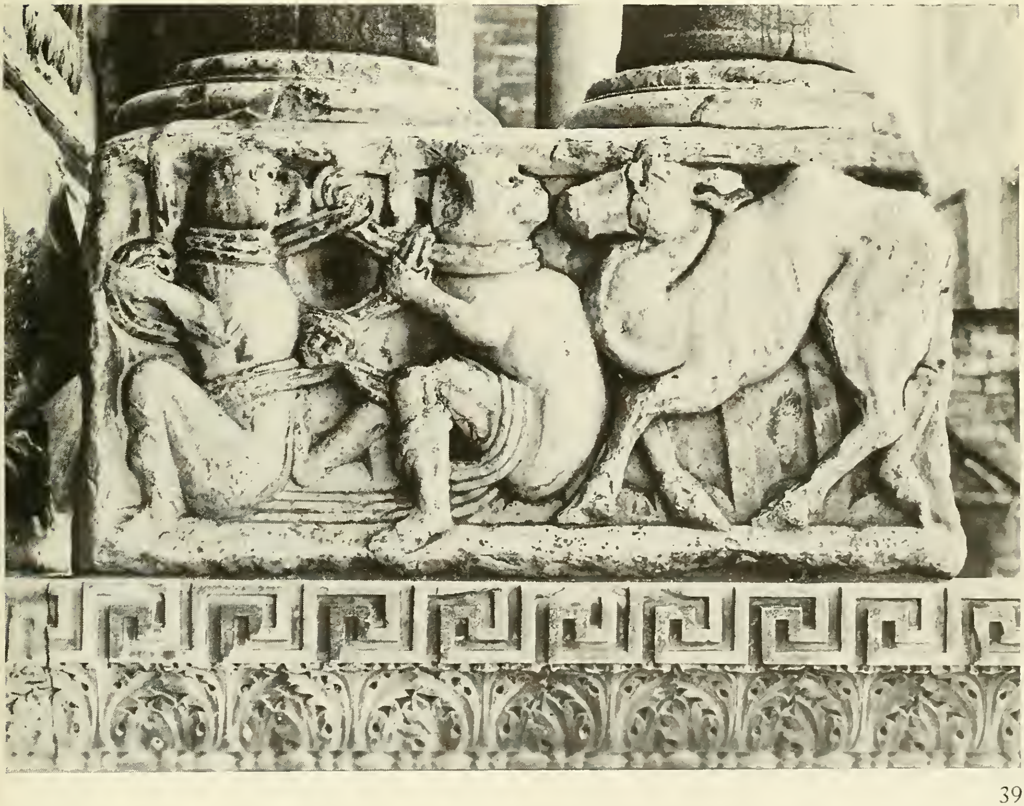
If we return now to the twelfth century and our subject of Romanesque art, which brings the first large-scale sculptural embellishment of the churches, we are struck by its terrible gravity. It has been said that the Christianity of this period was "a religion of threats." Indeed, in one church after another, it is the Last Judgment that confronts the faithful as they approach the church's main portal with its enormous tympanum. True enough, the Last Judgment reliefs usually divide the space equally between the happy blessed who have been saved and the unfortunate wretches consigned to Hell. But, if the tranquillity of virtue is ordinarily apt to pale against the colorful drama of vice, this is more than ever so in Romanesque sculpture. Hell enjoyed the attentions of spirited sculptural inventions and, no doubt, afforded one of the main attractions in the tympanum. In the Last Judgment at Sainte-Foy, in Conques, the activities in Hell have evoked marvelous monstrosities and tortures (pp. 34-35). There is no mistaking the calculated intention of this mournful work, for an inscription on the lintel warns: "Oh sinners . . . change your ways or know that a severe judgment is in store for you."

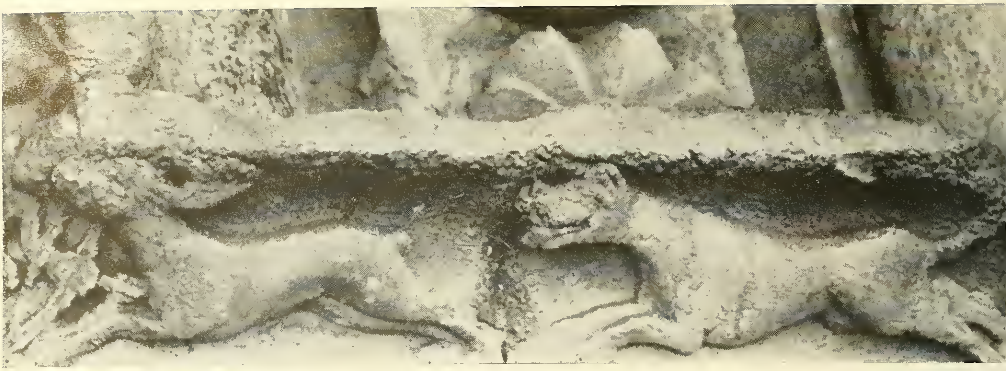
ANOTHER tympanum of the Last Judgment, in the abbey church of Beaulieu, shows a Hell in which monstrous beasts carry off sinners to torment them for eternity. In the detail reproduced here (p. 35), we find a griffin, a seven-headed beast of the Apocalypse, and parts of other beasts extending the length of the lintels. Only Romanesque style could lend such forms real force and terror, for the line is fine that separates fantasy from the ridiculous.

A second theme that found favor among the abbots who planned the church sculptures was the Majesty of Christ, showing Him in an almond-shaped aura, surrounded by the four symbols of the Evangelists. Only Matthew's symbol—an angel—employs the human figure. Mark's symbol is a winged lion, Luke's a winged ox, John's an eagle. These composites rank among the rare instances in which hybrid beasts belong to the category of positive symbolism, their textual origin stemming from the Biblical visions of Ezekiel and St. John. And if the winged ox and lion stir memories of Mesopotamian art, it is possible that Ezekiel's vision might have been colored by his familiarity with later Assyrian sculptures.

The fauna of art—painted and carved creatures of man's own creation—have often been examined for their scientific testimony as recorded observations of animals in nature and as a measure of man's empirical knowledge of zoology. Clearly, it might seem, here was logical and sound method. Its usefulness, more-

Chained apes and a camel, exotics rarely seen in France, may have been based on travelers' reports. These are on the central portal of the facade of Saint-Gilles-du-Gard.





Hunting scenes decorate church facade at Cahors.
Artist has managed to capture a sense of panic and speed as a stag, *left*, is pursued by giant hound.

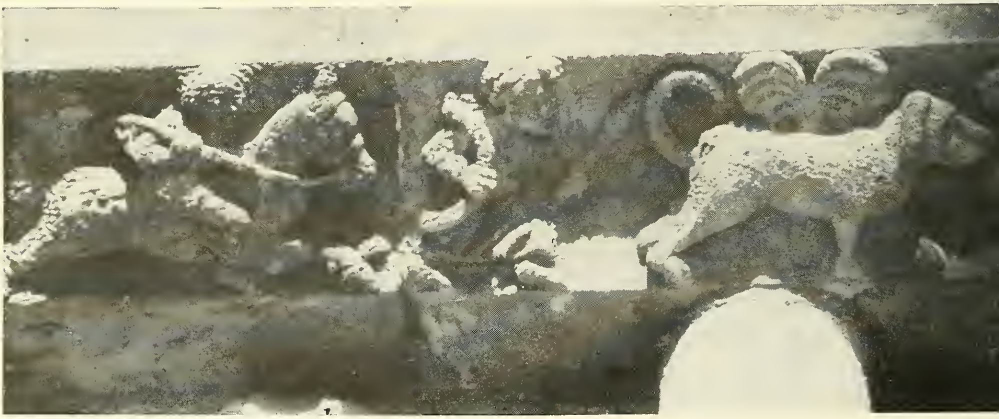
over, could be readily demonstrated in many areas, whether in Paleolithic cave paintings or in the Renaissance drawings of Pisanello.

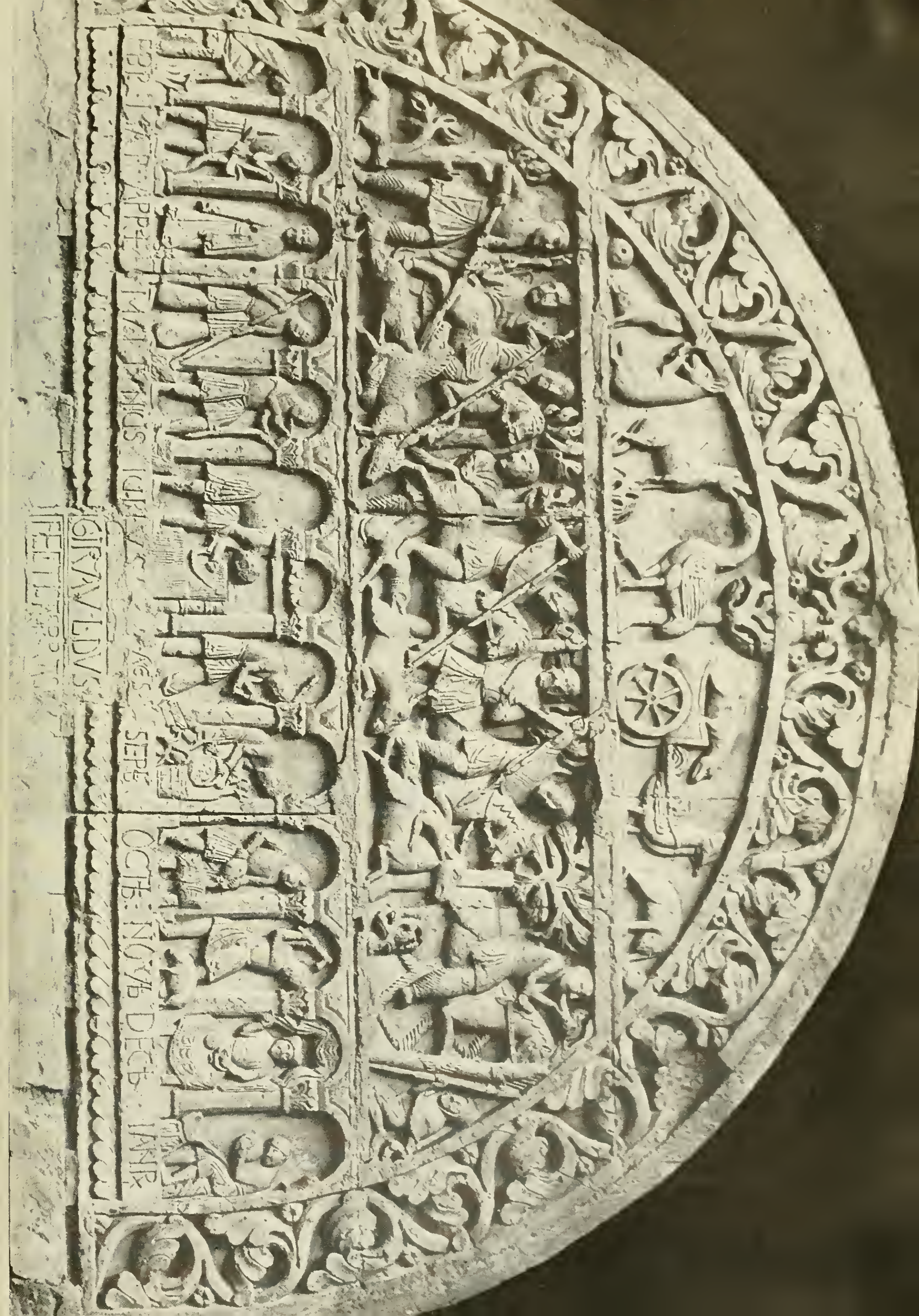
STRICTLY speaking, much of medieval art—and especially of Romanesque art—would be found wanting if viewed solely from this approach. Here and there we do find single animals that reveal direct and interested concern with the original, such as a bear at Carennac (p. 38), whose collar suggests that the sculptor had somewhere seen a trained bear. The splendid eagles that adorn cloister capitals and façades in Provence, however, have their ancestry in Roman sculptured remains that were still visible in the area, rather than in any studies of the species in nature. Trained apes could be seen in traveling animal shows, but such exotic fauna as elephants must have been copied from other works of art, or from pictures in the illustrated bestiaries. The sculptor of the camel on the socle of Saint-Gilles is altogether exceptional in that his relief is far superior in accuracy to those we know from manuscripts. One can only guess how he might have seen a camel or come by a reasonably accurate drawing of one.

In the main, however, one must not expect scientific naturalism in seeking to understand Romanesque animal sculptures. In its stead, we must try to recover, from the depths of primeval memory, fantasies of untrammeled childhood, its fables, dreams, and nightmares.

Also at Cahors, a mounted hunter, accompanied by his footman with bow and spear, follows a dog of modern, pointer-like appearance in pursuit of their quarry.

Aesopic figures top tympanum of Saint-Ursin, in Bour
At center, men with dogs hunt boars and stags. At bott
are shown the activities for each month of the ye

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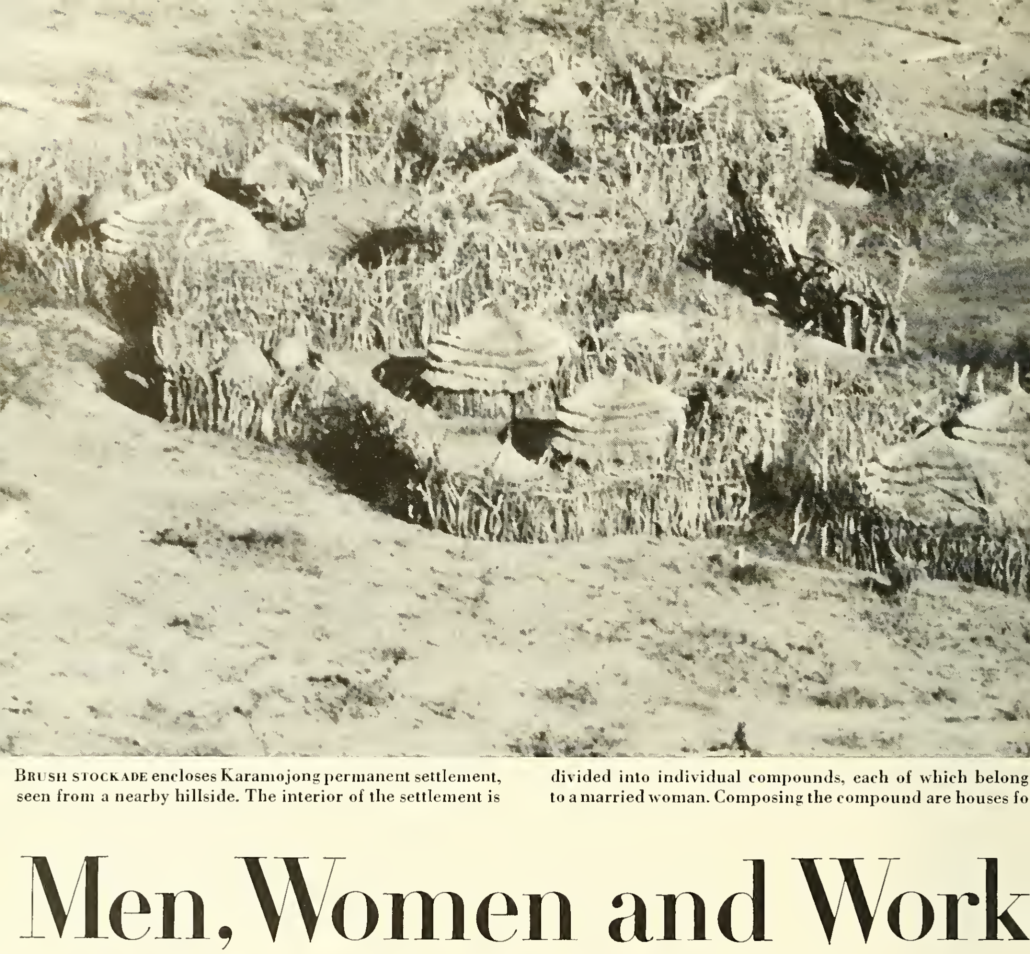


Brush stockade encloses Karamojong permanent settlement, seen from a nearby hillside. The interior of the settlement is divided into individual compounds, each of which belong
to a married woman. Composing the compound are houses fo

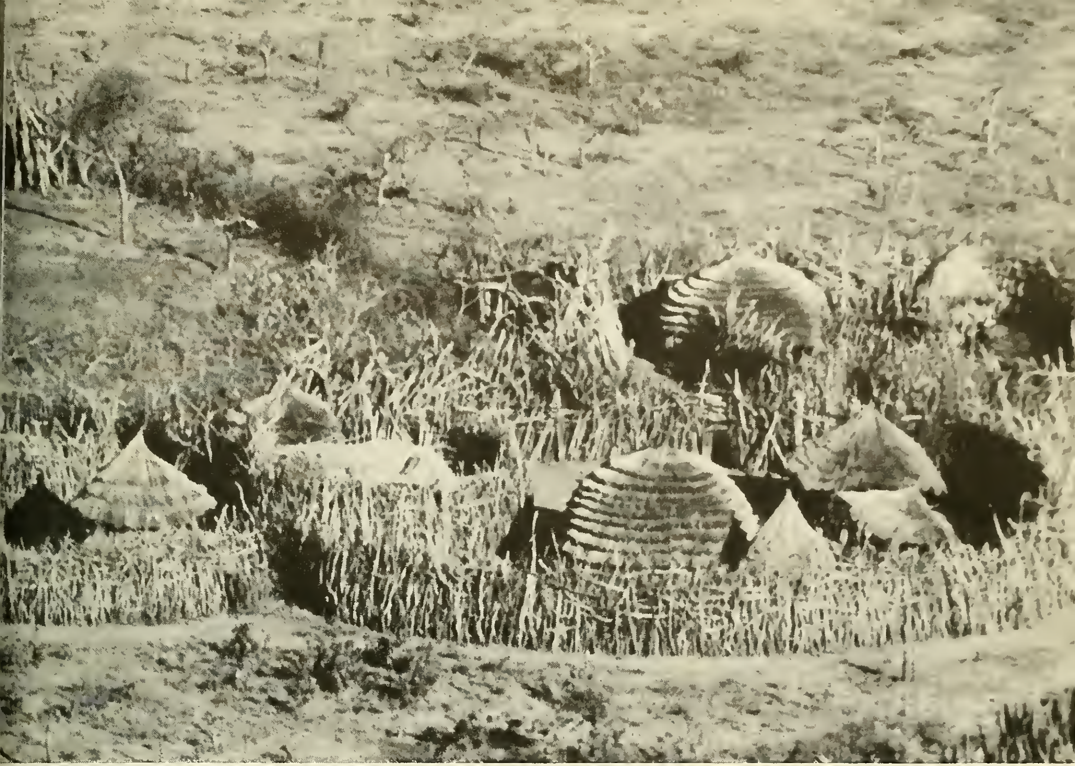
Men, Women and Work

A man is known by

By Rada Dyson-Hudson

IN THE NORTHEASTERN CORNER O
Uganda, where it borders on th
Sudan and Kenya, live the Karamo
jong, one of a score of African tribe
classed by language as Nilo-Hamitic
Karamojong tribesmen are closel
related to, and speak the same lan
guage as, many of their neighbors-
the Dodoth, Nyakwai, and Jie tribe
nearby in Uganda, the Toposa in th
Sudan, the Turkana in Kenya, and th

Fighting sticks whistle through the ai
as young herdboys stage a mock battle



sleeping and storage, as well as granaries. Cattle corrals and pens for small stock are within stockade, normally on the north side. Most women and many children remain in the settlement all year; men are often in outlying cattle camps.

In A Pastoral Society

the cattle he keeps

Nyangatom who live in a no-man's-land between Kenya, the Sudan, and Ethiopia. The environment shared by these peoples is harsh—desert or semidesert. The rainfall is often localized and is always unpredictable. Although Karamojong-speaking tribes are pastoral at heart, regarding cattle as their most valuable possessions, those who live in areas of relatively more favorable rainfall supplement

MILKING CATTLE is a typical activity in the Karamojong's pastoral existence.

WAVING ARMS and shouting, two young girls stand on a platform in a sorghum patch, scaring birds from the ripeni crops. Children take posts before daw

their pastoral economy by agriculture. The Karamojong themselves live in such an area of higher rainfall. The annual average is about twenty-five inches over most of the plains and thirty-five inches or more on higher ground and near the base of the mountains that constitute the tribal area. Women practice agriculture, and much of their diet comes from agricultural products. The first love of all Karamojong, however, is cattle.

In southern Uganda. through the year, banana trees remain green and one corn crop succeeds another. There are seasonal differences during the year—some months are hotter, some wetter—but the general aspect of the countryside never really changes. Karamojong country changes each year—from burned red desert to lush green grassland to burned red desert again. During the dry season—late September to March—the sun bakes the countryside and burns the grasses; trees shed their leaves and look bleak and dead. Cattle and people grow thin as food becomes scarce. In the rainy season—April to early September—grass sprouts from the red earth, trees are once more clothed in leaves. fields are planted and grain grows and matures. Cattle become fat and sleek, and food is plentiful again.

THIS pattern is considered "typical." Actually. the rainfall in Karamojong country is extremely variable. Some years. ample rain may fall every month. Then the country will remain green all year. Other years, the rainy season brings only meager showers. Then water sinks but a few inches into the ground, grass scarcely grows. crops fail, red dust covers the country, and cattle and people die of starvation.

To the geographer, Karamojong country is a plateau—3.700 to 4,500 feet above sea level and two degrees north of the Equator. To the Karamojong herder. the country is rather a gently undulating plain strewn with many small hills and scattered rock piles, and ringed by four great mountains, remnants of long-dead volcanoes. From these mountains flow semipermanent springs. These, together with permanent swamps on the western edge of Karamojong tribal land, are the main sources of water for cattle during the dry season. But the most reliable sources of clear water are the central. sandy portions of major rivers. These rivers start as steep, rocky tributaries in the east. turn into broad. meandering, sandy streams in central Karamojong country, and become seasonal swamps in the west. After the torrential downpour of a local rainstorm. rivers come down in a great flood; the water level may rise six or seven feet in less than an hour. Riverbanks are undercut by the flood's immense power; trees are swept away, and sometimes cattle and people are drowned l rushing waters. The flow subsid rapidly. Within two or three day river beds are dry again. But in the central, sandy portions, water h been stored underground.

WOMEN come daily to fill cl pots from wells dug in th sand. Just after the rains, the we may be only a few inches deep. b the water level drops as the dry se

son progresses. In a dry year, people may have to dig fifteen feet to reach water. Three or four people are then needed to fetch water; one stands in the bottom of a well, scoops water into a gourd, and passes it up to the next person, who stands on a ledge cut in the side of the well. She, in turn, passes the gourd to someone else, standing on a ledge above, until finally the water is at the level of the river bed and is carried on the heads of the women back to their permanent settlements.

All permanent settlements are in a relatively small area in central Karamojong country. Most are within carrying distance of a well in a sand river and within walking distance of a rich alluvial terrace near a riverbank, which yields excellent crops. Settlements are stockaded for protection against wild animals and human enemies and divided internally into corrals for stock and compounds for people. Every married woman (except a newly married bride) has such a compound, where she lives with her children, prepares food, eats, sleeps, and entertains friends. It is her private domain. Each compound has a small gate where a visitor must pause and ask permission to enter. Entering without asking is very ill-mannered. Within the compound are one or two sleeping houses, a storage house for domestic utensils, one or more grain storage baskets, an open fireplace, and an open-sided shelter for protection from the intense sunshine. Even a husband is really a guest in his wife's compound, and has no specific place of his own there. The men's place is on the other side of the settlement—the *aperit*, a sleeping place near the corrals. Older boys and young men often eat there rather than in their mothers' or wives' compounds and they sleep there to guard the stock from thieves and predators at night.

During the rainy season, settlement life begins long before dawn. The first activity of the day is the women's—to churn the previous evening's milk. Before first light, children are awakened by their mothers. Shivering and hugging their thin bodies for warmth, they go to the cattle corral, each child carrying a wooden tub. As a cow wakens and raises her tail to relieve herself, whoever spies the movement shouts and runs across the corral to catch the urine in a tub. It is used to curdle milk, clean out milk gourds and churns, and wash and warm the cold hands of the waiting children. As the tubs are filled and the sky lightens, older girls and younger wives come to the corral to begin milking—a task that must be finished before the settlement's clouds of flies become active at dawn. A calf is allowed to suckle briefly, then is tethered near its mother to the corral fence or is held by a small child while an older girl milks the cow. The calf may then suckle again. At full daylight, the cattle are driven from the village to graze and calves are separated from their mothers until evening.

COLD sorghum porridge left over from the previous evening may be finished before the people set out on their daily jobs, but many start the day with nothing to eat. Men and boys tend herds of cattle, the goats, and sheep. Women and girls cultivate

PUSHING GOAT into a stock pen, *right*, is last task of day for 8-year-old lad.

YOUNG WIFE stirs porridge in cattle camp shelter. Younger brides and nubile girls follow their husbands or friends to camps in dry season, but live apart.

SPEAR TIP is tool for a man braiding a leather collar for favorite ox. Later, holding same spear, man was killed in cattle raid against neighboring tribe.

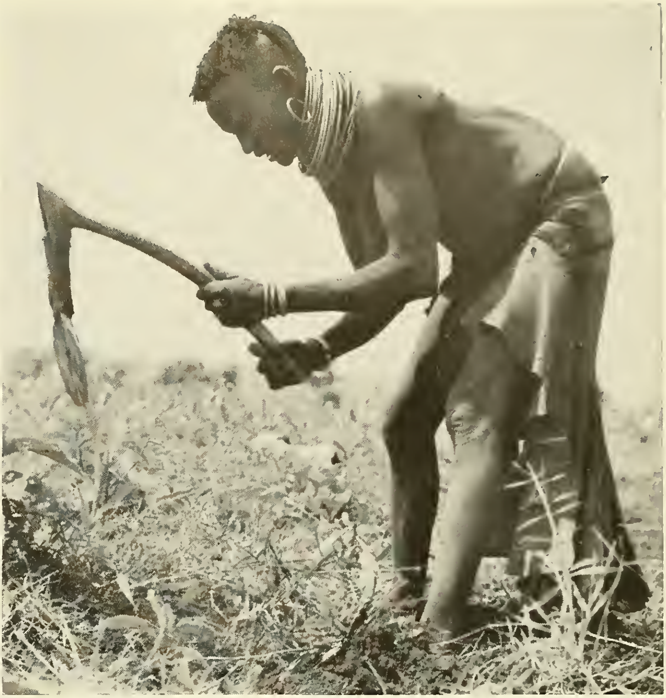
WALLS OF SLEEPING HOUSE are built o sticks tied with bark strips. Althoug

fields and attend to domestic tasks– grinding grain, fetching water, an collecting firewood.

During a period of heavy work, a woman and her daughters may take a cooking pot to the field and prepare porridge at midday. The herdboy will snatch quick meals, milking the goats directly into the palms of thei hands, picking wild fruit, digging edible roots, and robbing bees' nests o their honey. But the evening meal i the main meal for everyone in the settlement. It usually consists of sorghum porridge, mixed with sour mil if cattle are staying in the settlement or with boiled herbs, fruit, fat, o dried vegetables at times of the yea when the cattle are far away.

By dark, everyone has returned t the settlement. The cattle have bee milked again, the evening meal ha been eaten, and the settlement gate are blocked for the night with large thorny branches. For a short time people visit between compounds t

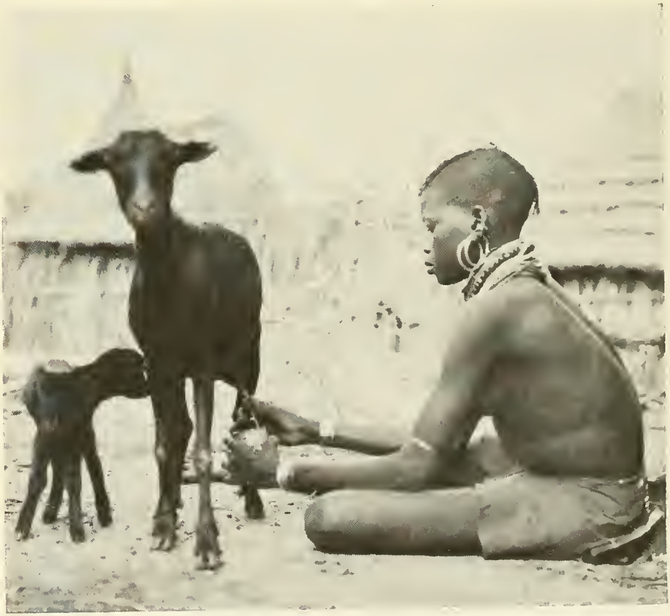
woman, *left,* has two co-wives living in village, she prefers neighbor's aid.



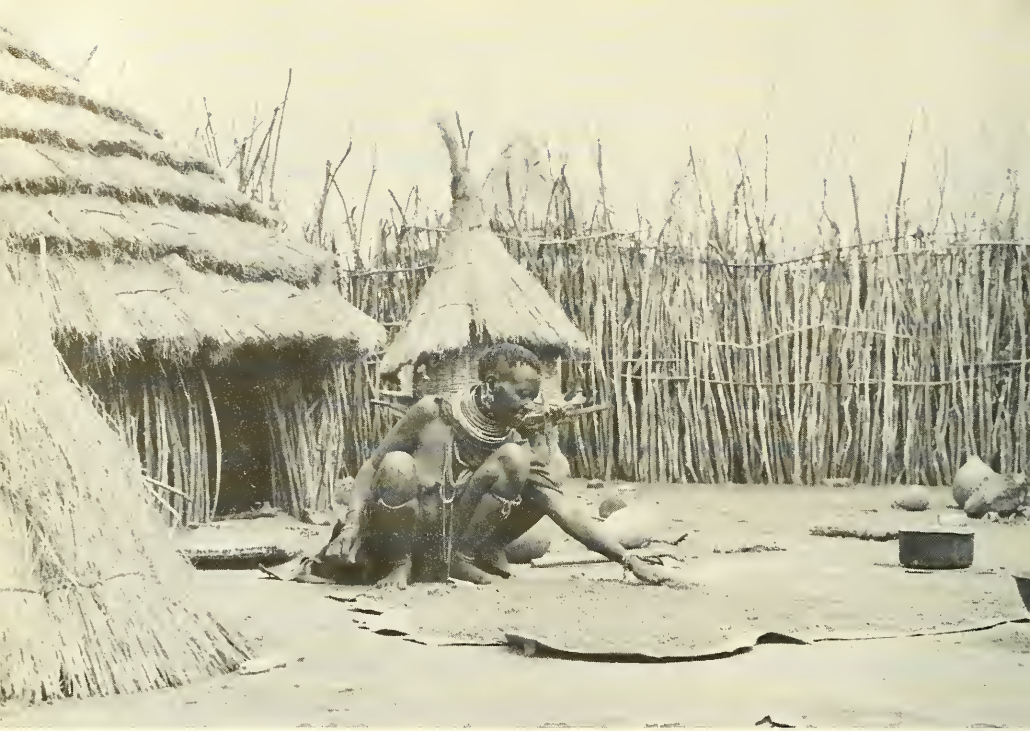
Primitive hoe is used by a woman to cultivate a grain field. Metal blades, once got by tribal bartering, are now purchased from a Somali trading post.

gossip and perhaps to share a pot of sorghum beer and to sing. Then fires are built in the sleeping houses and at the corral guards' post, untanned cowskins are unfolded on the ground, and all settle down for the night. The stick walls of the houses, although solid enough for shelter and to keep smoke inside the houses, do not block the many sounds of the night. One hears the occasional wailing of a child, the continuous, guttural coughing of goats, the restless stamping of cattle, and hyenas howling outside the settlement. Whoever wakes up pokes the fire, adds a log, and goes to sleep again—until, before dawn, daily activities begin again. Interruptions in this general routine come only when public or domestic ceremonies are held in the village.

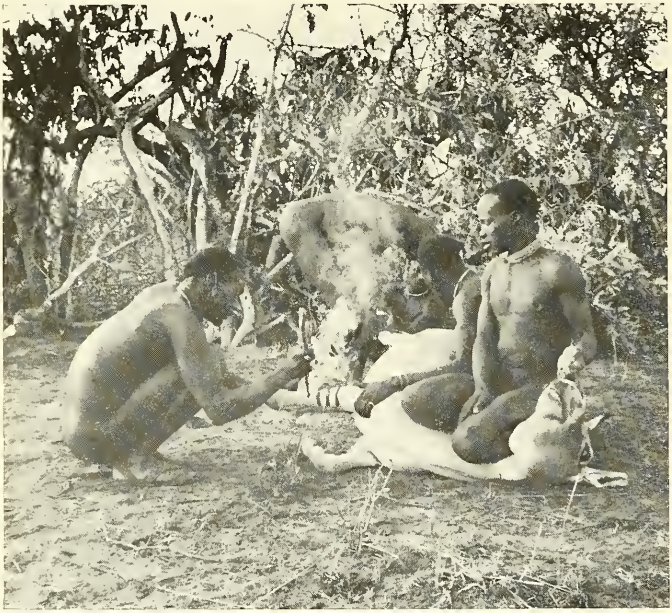
The days are not without change, however, for there is a yearly cycle of activities in the settlements. October and November are transition months. The rains have ended in September;



Few ounces of goat's milk is sole milk ration for village children during dry season, when other livestock must seek food and water far from the settlement.



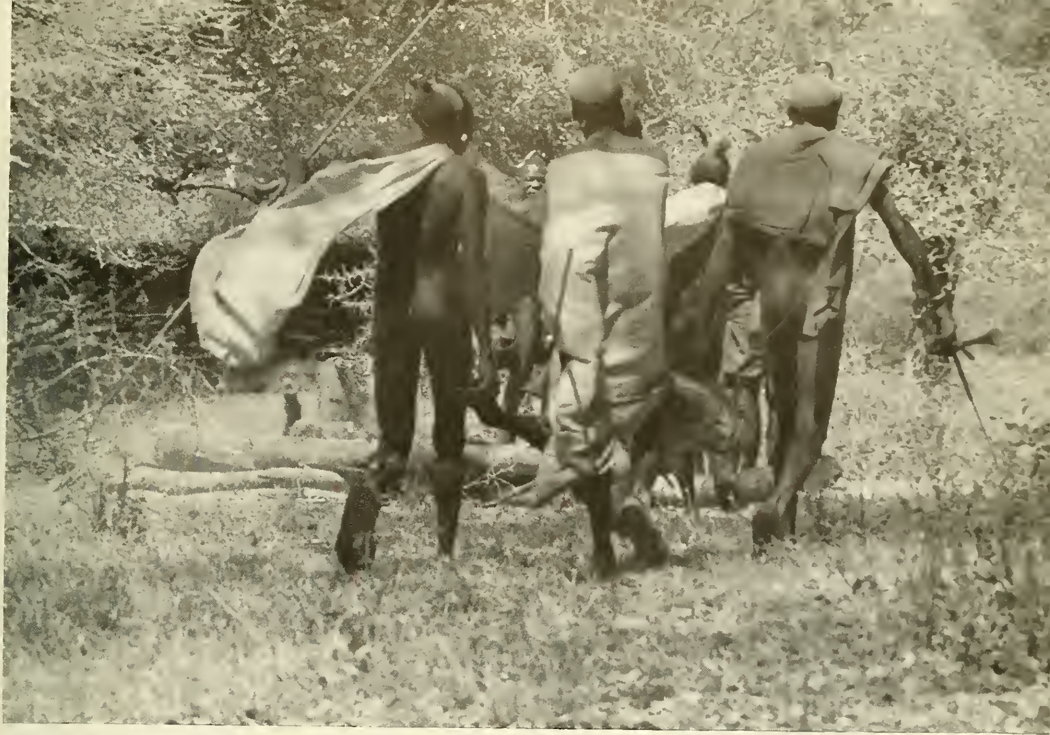
SORGHUM IS SPREAD on cowhide in sun to keep down weevil infestation. Regular sunning can preserve grain from one harvest to next. In background, at left, is sleeping hu of woman; directly behind her is a woven basket for grain



AGE-MATES COLLABORATE in branding a donkey used as beast of burden. No proud Karamojong man will carry more than his weapons and his wooden stool.

grain has ripened, and the grass ha dried and turned yellow. The wome gather tall grasses for thatch an thresh the harvested sorghum. Skille men weave supple branches into storage baskets for grain and replac those that have collapsed since the las harvest. As grazing becomes spars near permanent settlements, cattl herds gradually move out toward dr season grazing areas—some only few miles away from the settlements others as far as seventy-five mile away from the Karamojong villages

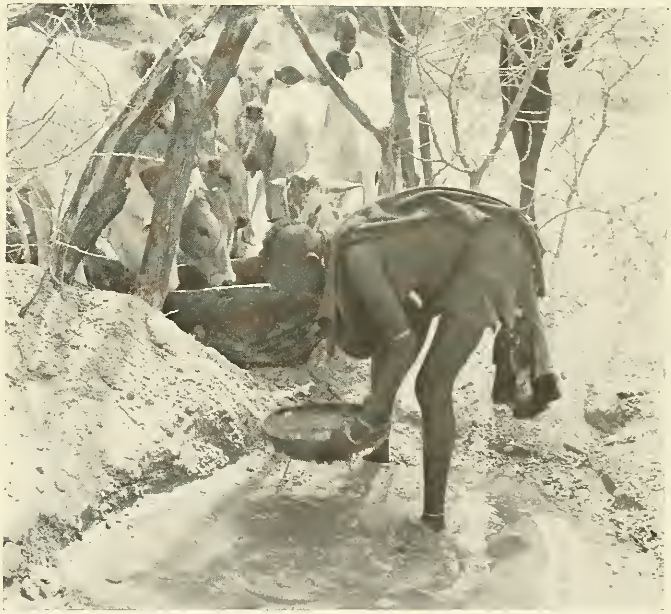
DECEMBER, January, and Februar are the hottest months of th year. The men are away with the cattle, moving over dry season grazin grounds in search of grass and water Small children go with them, particularly if the previous harvest was smal and grain is in short supply: they ca live on the cattle's milk. Those wh can, walk; the youngest are carrie on the shoulders of older brothers an fathers. A few men remain in the settlements to protect the older wome and nursing children who are ther



Strong adult males carry hindquarters of sacrificed ox across ceremonial ground. "Sacred" hindquarters are to be laid before assembled elders, who will pray for blessings on land, stock, and people, then feast on sacrificial meat.

throughout the dry season. The women work in a desultory fashion. They finish threshing; they sprout, ferment, and grind sorghum to prepare beer flour; they rebuild their compounds and houses that have been ravaged by termites.

In February, women begin clearing thorn trees from land to be used for fields, and building fences round cleared ground with the cut branches. Husbands return to the settlements for a few days to aid their wives in this work, often walking fifty miles or more, staying several nights, and returning again to their herds. This work of clearing and fencing is the only agricultural activity in which married men regularly help their wives. If there is a bumper crop, men may assist with the harvest, but only a man with very few cattle helps his wife cultivate her fields. Among



Precious water is dipped from sandy hole as cattle drink from wooden tub. Waterholes are carefully tended, since they are vital to villagers and herds.

Dr. Dyson-Hudson, now lecturing at the University of Khartoum, and her husband, Neville, spent nearly three years with the Karamojong. They took the photos illustrating this article.

SEATED NEAR FIRE, men and boys in a cattle camp talk at evening. Tree still standing near cleared sleeping area i convenient prop for the men's spears

AERIAL PHOTO shows abandoned site of stock camp, *left,* and camp shared by three herds, which occupy separate corrals, subdivisions of big stockade.

the Karamojong there is rigid division of labor. The men look after stock, and animals are theirs to allocate or dispose of. Women raise crops, and grain is their private property, to keep, to share, or to trade as they wish.

ONLY after the season's first good rainfall does agricultural work begin in earnest. This may be any time from late February to early May. While the ground is moist and soft, women hoe the fields and plant their seed, interplanting sorghum with cucumbers and marrows. Drought often follows a rainy spell and seeds germinate only to die. But the women re-sow at the next rainstorm and succeeding ones until mid-June.

In June, work in the fields shifts gradually from planting to weeding. June and July are crucial months, for by August the harvest size will be known. From late July to mid-August is a busy time for the children. They must be in the fields before dawn to scare away small weaver birds, finches, and doves that come in dense flocks to eat the still soft, but maturing, grain. This is the coldest time of year; in early morning, smoke rises from fires on platforms built amid the tall grain. The children drive away birds by flinging mud pellets that have been stuck to the end of long supple sticks, and shouting "kurri—kurri—kurri." At midday the birds are less active, and the guards can rest; but in the evening the children are busy again, waving their arms and shouting until they are hoarse. Only at sunset may they return home to the warmth of the cooking fire and the comfort of the evening meal.

As the grain hardens, birds become less of a menace. Now that the crop is assured, women begin to repair and build storage houses for the coming harvest. Hills and riversides echo with their songs as they cut heavy, forked uprights, trim flexible poles, and strip bark for fiber with which to bind the poles together. Grass, carefully hoarded from the past autumn, is used to thatch the shelters. In August and September comes the harvest. Occasionally, all seeds sown between March and June mature, and a bumper crop is reaped. That is a year of great rejoicing—feasting, ceremonies, and dances mark the harvest time. Usually, however, only some crops reach maturity—barely enough to feed each woman and her family until the next year. Sometimes each rainy spell has been followed by a three- or four-week drought, and no crops ripen. Then the people face hunger in coming months.

ANIMALS enable the Karamojong to survive such periods of crop failure. People in areas of total crop failure drive their goats to trade with more fortunate neighbors. Sometimes, although crops fail, rains have been sufficient to maintain some grasses, and cattle continue to yield milk. Or, if the cattle starve, people subsist on the meat of the animals that die. In time of famine, a man will slaughter a goat, or very rarely an ox, to feed his family. Thus, by exploiting crops and herds, the Karamojong survive environmental vicissitudes that might else prove fatal.

If their permanent settlements only were observed, the impression might be that the Karamojong are agriculturalists who also keep animals to supplement their diet. The true pastoral nature of Karamojong life is fully revealed, however, by a look at the cattle camps—inhabited by tall, naked, free-striding men who live as herders.

ALMOST without exception, every Karamojong man owns cattle—anywhere from five to five thousand head. Guarding cattle is his way of life: the animals provide both the means by which he can marry (every close relative of his bride must receive at least one animal during the wedding ceremony) and the means by which he feeds himself and his family.

Optimum size for a Karamojong herd seems to be from one hundred to two hundred head of cattle. A man with less than this will join with a rich relative or friend; if he has very few cattle, he exchanges his labor for food. A man with hundreds of cattle will split his herd into smaller units, each in charge of a grown son or other close relative. Often, two men from the same settlement, each with his own herd, will share herding responsibilities as a form of insurance. One man will take a part of both herds to one area of the country; the other will herd the rest elsewhere. In a land where many cattle may be wiped out by thirst, starvation, and epidemics, or may be stolen by enemy tribes, a wise Karamojong never keeps all his stock together in one large herd.

SHORT-HAIRED SHEEP are driven into the central corral of a cattle camp by a young girl. She does not mind task because she is young, but she would be

SHIFTS in grazing land the Karamojong make in their semiarid country are opportunistic, and therefore complex. Several forces influence cattle movements. One is the herd leader's tendency to go each year to an area he knows well. Another is his desire to be near his settlement so he can keep in touch with his family and supply his dependents with milk. A third is his desire to go where grazing and watering conditions are best at a given time. Circumstances underlying the decision of each herd leader dif-

SON HOLDS GOAT as father removes a thorn from hoof. Herds are hereditary.

ashamed should a shortage of brothers force her to help with the herd as she grows older. Livestock are concern of males, not pursuit for a growing girl.

fer, so no two herds move in identical orbits, nor is a single herd likely to repeat the same series of moves in any two successive years.

Although permanent settlements are confined to the relatively small central area of tribal land suitable for agriculture, cattle camps are widely scattered. Storms are capricious. Rain may repeatedly drench one area during the dry season, leaving the rest of the plains dry. Or showers may fall first in one part of the country, then in another. It is by means of temporary cattle camps that herds are able to exploit such rapidly changing conditions.

Each cattle camp is essentially a cluster of corrals, surrounded by a strong fence and perhaps containing a few rough shelters for the herdsmen. As the conditions of grazing and water at a particular place deteriorate, the camp is abandoned, at the herd leader's discretion, and the herds move to places where conditions are better. The men then make another camp. First they build a stockade to protect the livestock. Then separate corrals are made for the different herds, and finally they build shelters for themselves. The camp site may be occupied from a few weeks to several months. People who are herding in the same area often build together—for protection and for company—but each herd has its separate corral, and the decision to move is based entirely on the judgment of individual leaders. After a few weeks, some abandon a camp and seek better grazing elsewhere; others decide to stay longer.

LIFE in cattle camps is austere, often intensely uncomfortable, and sometimes highly dangerous. During the rainy season and early in the dry season, only men live in them. Although nights are cold, the men sleep naked in the open, near the corrals, where they can hear every noise and sense every mood of the cattle. Each man has a cowhide to sleep on; between every two men is a small fire. If it rains, each man wraps his cowhide around him for protection. Only

HERDBOY'S DOG shares boy's food and work, is fed herbs "to make it fierce."

in a downpour will the men flee to their crude shelters of sticks and straw. When the storm ends, they return to their places near the cattle. As the dry season progresses and agricultural work in settlements is finished, young wives and girl friends visit their men. Each woman brings a pot of beer to insure her welcome. If a girl is invited to stay, she may build a small house and remain in camp until it is time to return to the settlement to clear her field. If she is not made welcome, she will stay a few nights only and then return home.

The visiting women bring their own grain, which they cook, adding to it whatever milk is given them by the herdboys, and they eat apart from the men—who now subsist mainly on blood and milk. Women build their shelters to one side of the camp, not near the men's fires. At night, a man may visit his wife briefly—but he will return to his sleeping skin to be near his cattle and guard them through the night.

When no women are available to carry it, there may be no water in camp or, at most, a few tiny gourds of drinking water. All utensils are washed in cow urine; so, long before first light, herdboys must be at the corral ready to collect it. Next comes milking. Wooden tubs, each shared by two or three boys, are lined up near the corral entrance. Each cow is milked into a long, graceful milking vessel of wood; then her milk is poured into the appropriate tub—milk from a particular cow going to a particular group of young boys for their early morning meal.

When the sun is well up, the restless stamping of the cattle, as they grow more anxious to start grazing, becomes intense. The gates are opened, and the herds leave camp, followed by goats, frisking and bleating as they scamper toward freedom. The boys call their dogs and set out to watch the herds. Younger boys—six to eight years old—watch calves. Eight- to ten-year-olds guard goats, while boys of ten years and more guard cattle throughout the day.

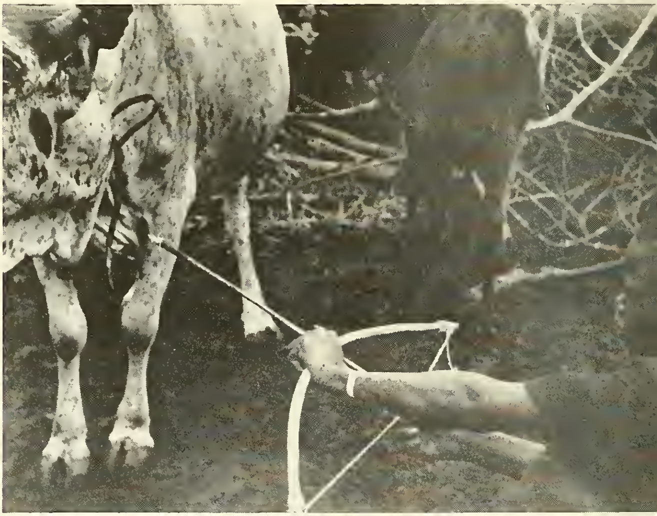
During the day, the camp is deserted. Small children, five and six years old, take charge of kids and lambs. These are confined in a small thorn enclosure near the camp. Grown men sometimes help with the herding. During the dry season, when water is scarce, they supervise the watering, making sure that each animal receives enough, but that none lingers at the water hole and drinks more than his share. If enemies are reported nearby (despite efforts by the British Administration, cattle-raiding between Karamojong and their eastern neighbors is a frequent occurrence), the herd leader accompanies the boys, carrying two spears and, in addition, a tough shield made from hide.

But often the men are not with the herds. They may be sitting in the shade of a tree near camp, carving stools and wooden bowls, gossiping with neighbors, or simply sleeping. However, even when they seem to be relaxed, the Karamojong are in fact very much occupied with cattle matters. While engaged in apparently aimless gossip with other men, they are learning about grazing conditions elsewhere, getting reports of cattle disease, or receiving news about enemy raids. Routine matters are left to children, but the men are ever alert—ready to supervise and guard their beloved stock from any threat.

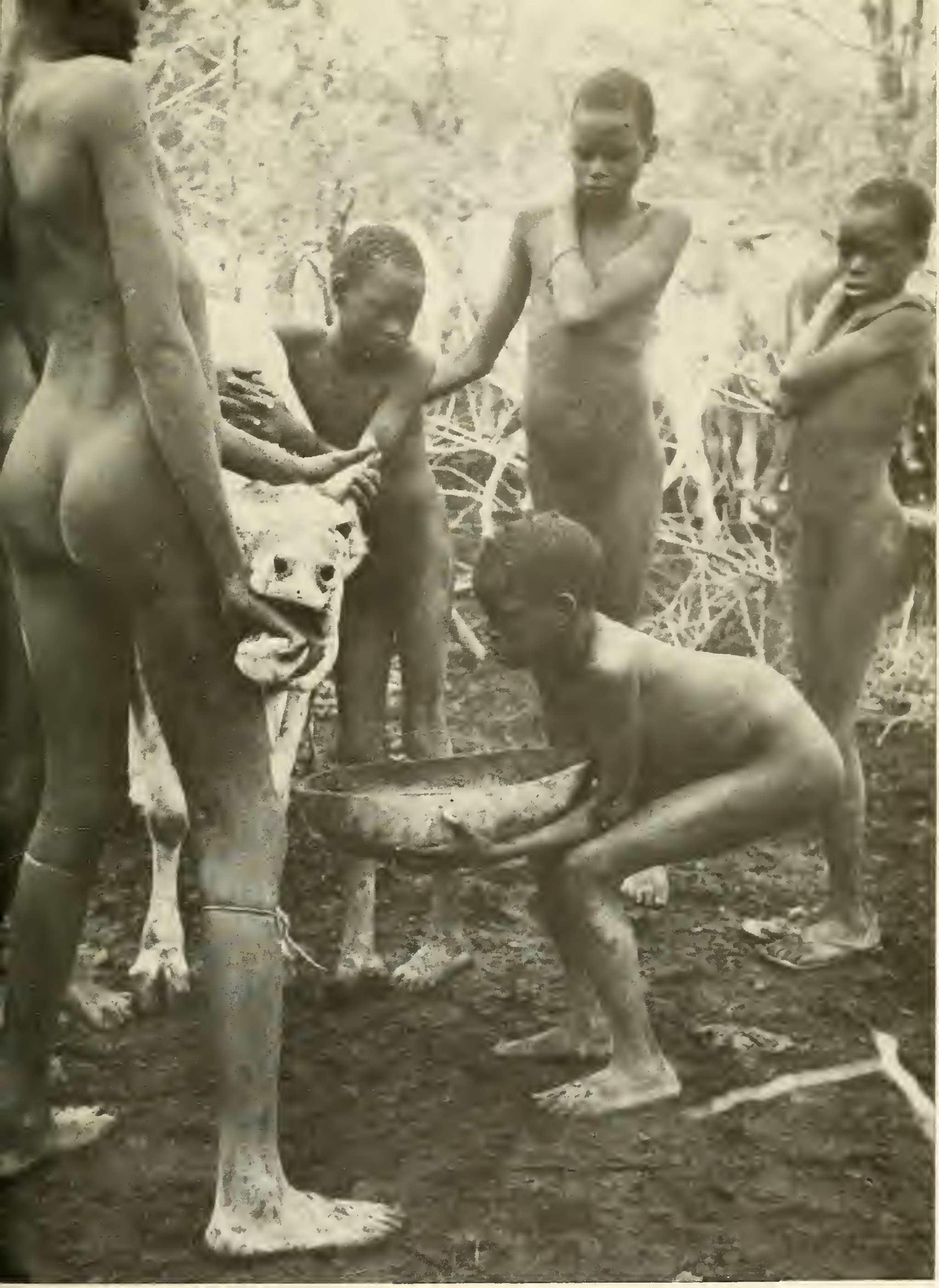
As the sun nears the horizon, the noises of returning cattle grow. Each boy returns with his herd. Sometimes the boys also bring a tiny gourd of drinking water or a piece of dry wood for the night fires. When the cattle are safely directed to their corrals, the boys select an ox for bleeding. A braided leather noose is tighten
around its neck and a blocked arro
is shot into the distended jugular vei
Blood pours out and is collected in
wooden tub. The amount of blood
carefully gauged: when the anim
has been bled enough, the thong
released and bleeding stops. Shakin
his head, the ox rejoins the herd.
small boy briskly stirs the blood
remove clots: it is then divided amo
the wooden tubs laid out for the ev
ning milk, which is added to t
blood. The mixture is the evenin
meal for men and boys.

Gradually, the camp settles dov
for the night. Should two bulls sta
fighting during the night, howeve
the owners are immediately up to pa
them. Should the dogs bark in alar
the men spring up and seize the
spears—propped against a convenie
tree in camp. They rush out, shou
ing, ready to face animal or enen
raiders. After each disturbance, th
settle down—until just before daw
when the children must go to the co
rals again to begin a new day's wor

Attendance on the needs of the
cattle continues from day to da
for the Karamojong, through all se
sons. It is not, like agriculture, su
ject to periods of rest or changes
activity. He may herd close to his se
tlement in the wet season and f
from it in the dry season, but th



Blocked arrow is shot into jugular vein of ox to obtain blood for evening meal. Leather noose tightened aroun
neck of beast causes vein to disten



Blood spurts into wooden tub from which it is doled to herdsmen and boys. It is drunk "straight" or combined with milk. When enough blood has been drawn, thong on neck of ox is released, bleeding stops, and the animal ambles off.

activities of the herder remain changeless during the whole of his life.

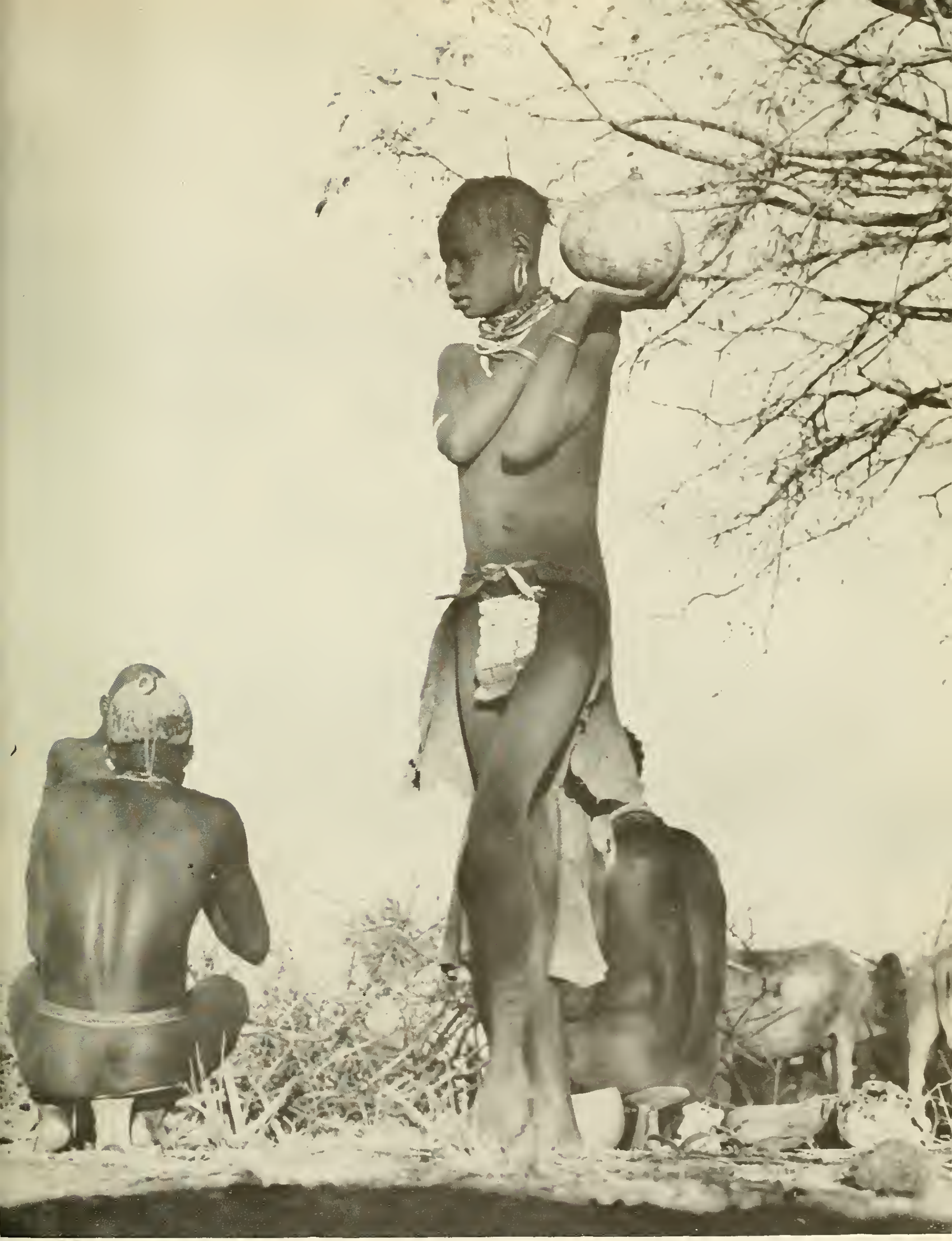
For the Karamojong cattle represent status as well as wealth, objects of affection as well as attention. Men sing poems to and about cattle, as well as milk them. They decorate their favorite beasts with collars and bells, as well as bleed them for food. A man marries with cattle, secures rights in his children through cattle, supports his dependents by means of cattle and, when he dies, is laid in a cowhide and buried beneath the dung of the cattle corral.

Nowhere can this close personal attachment and identification between a man and his cattle be seen more clearly than in the Karamojong custom of "name oxen." Every Karamojong boy is given a calf by his father: it is the first animal he owns. He shares with the calf the blood and milk he receives as his own food; he weaves for it a collar from wild sisal string, and makes a bell for it from the shell of a tortoise. He gives it names according to the colors and marking of its hide, and makes poems about it to sing while he is herding. He trains its horns into a decorative shape as they grow, hammering them with a stone and tying them into position with thongs made of leather.

The ox and his master grow together, and are closely identified. As the boy becomes a man, his name of respect is "father of" his ox—"father of the black striped ox"; "father of the ox that is patterned like an ostrich." This joining of man and ox is more than a matter of names. If his beloved ox dies, the man will grieve, and friends will travel miles to console him.

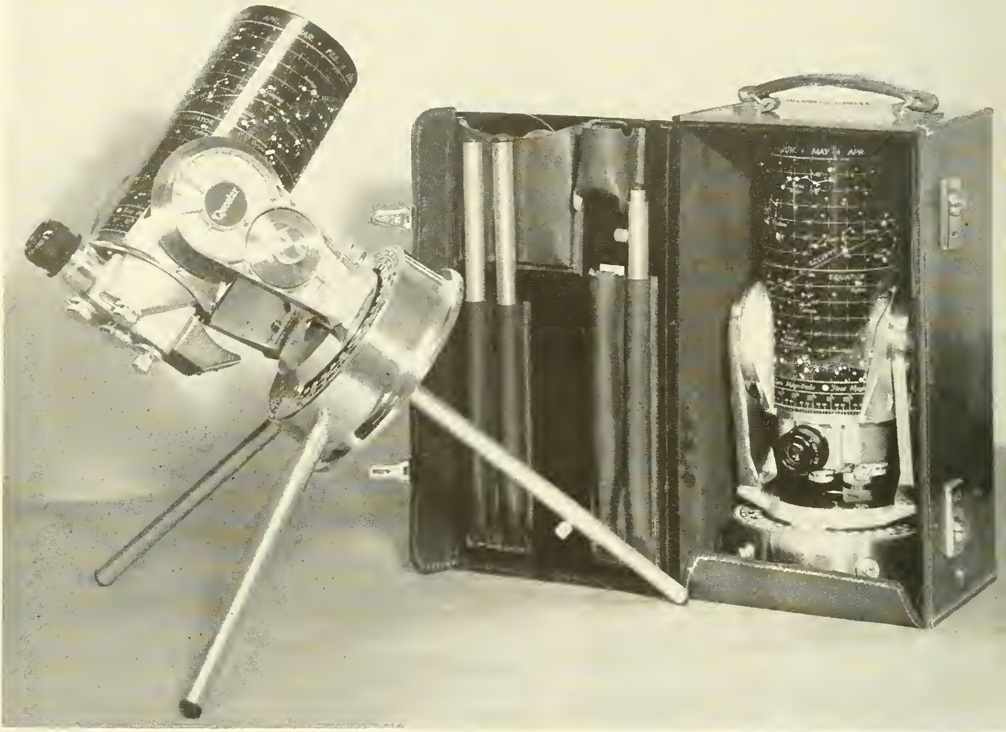
Living in an uncertain environment, with few technological resources to protect them from caprices of nature, the Karamojong often suffer. When crops fail, men and women complain bitterly that there is hunger in the land. But when misfortune affects the cattle herds, neither men nor women openly complain: they mourn silently, as over the death of a relative. Among the Karamojong, a man without cattle is a poor man and, since he has no voice in public affairs, insignificant. Worse, he is, so far as the Karamojong are concerned, a man without purpose, without interest: it will be said of him that "He lives for nothing, he grows old in vain."

GIRL WITH GOURD fetches water for
group of men in cattle camp. If the



are no women available to bring water to them, men may not have any in camp.

While playing the lead in the Broadway musical "Greenwillow," the distinguished American actor Mr. Antho Perkins phoned us from New York. We learned that he had used telescopes since boyhood, has a 4-inch refracto and had practically memorized our booklet. He asked some questions and in June took delivery of a quartz-mirror Questar. When asked how he liked it, he said, "Your booklet does not do it justice." We asked if we could quo him in this space. "Indeed yes," he replied, "but change that to read 'no catalogue could do it justice.'"



LAY THAT BURDEN DOWN

When you finally get tired of lifting and carrying your telescope in and out of doors, tired of setting it up and taking it down in chilly darkness —

When you've had enough of heavy loads, of quivering tubes and images, enough of drives that falter and slow-motions that fall short —

When you finally realize that it has become too much trouble to use your telescope any more because it only gives you an aching back and a pain in the neck — when you've had your fill of the whole unhandy contrivance — *send for the Questar booklet!*

The Questar booklet will tell you how to lay your burden down. No more lifting, no more toting, no more setting up of heavy, clumsy parts. Questar weighs but 7 pounds. It is always assembled, always ready to use.

It will tell you how Questar stands alone, the only thing of its kind, with the latest kind of optics, the mixed lens-mirror system of the new catadioptric optics. How Questar's folded focal length keeps it fabulously short, how so short a telescope can be as stiff and rigid as a great observatory instrument. It will tell you how Questar's images are as rock-steady as a microscope's, how its controls are ready to your fingertips, and how its 360° continuous slow-motions have a buttery smoothness with absolutely no backlash at all. It will tell you of finer performance than was ever dreamed of from only 89 mm. of aperture, and prove that point by the amazing resolution of the photographs it takes.

But hold on — let the booklet tell you this — let us use this space to tell you other things.

Let us speak, for instance, of investment value. Questar costs no more than ordinary 'scopes would if they were so well mounted as to be equally solid and vibration-free. But let's face it—Questar optics cost more by the extra hours of human labor required to make, for example, mirrors that must be 16 times more accurate of figure than the ordinary kind. Questar's mounting, too, has over 235 separate parts, each one of the best procurable alloys down to the last small stainless-steel screw.

So let us tell you what we have found o — that Questars are so greatly in dema that the few which reach the second-ha market depreciate an average of less th 7% per year! Imagine this — telescop 3 years old may bring 80% of their pu chase price! We know of few manufa tured products with such amazingly hi value at resale.

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SKY REPORTER

Clusters of a hundred thousand stars

By Simone Daro Gossner

Only large telescopes, assisted by modern photography, are capable of revealing the true appearance of those formidable stellar aggregates known as globular clusters.

To the naked eye, these objects look like ordinary stars, while a small telescope shows them as fuzzy dots, rather similar to a tailless comet. The French astronomer Messier, an ardent comet hunter, included them in his *Catalogue of Nebulae and Clusters* merely because he wanted to avoid pausing to wonder whether they might be comets after all.

Before the improvement of photographic processes, astronomers had no alternative but to sketch celestial objects as they saw them through their telescopes. A severe drawback of this technique is that the observer tends to interpret what he sees and may incorporate some alien features into his sketches. Witness (top, *right*) the drawing of a globular cluster executed by Louis Trouvelot—a noted specialist in such matters—and published in the Harvard Observatory Annals of 1874. This cluster is found in the constellation of Hercules. It is the ninety-second entry in Messier's catalogue and, for this reason, is commonly designated as M92. The S-shaped feature in the center is wholly spurious, probably inspired by the spiral arms that are present in other celestial objects (galaxies). By contrast, a modern photograph of M92 would look almost exactly like that of M3 reproduced here, another globular cluster, in the constellation Canes Venatici (center, *right*).

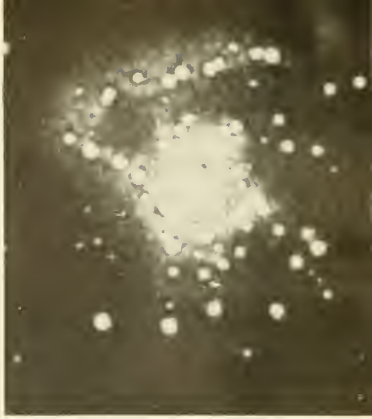
Known globular clusters in our Milky Way galaxy number barely over a hundred. Since few have been discovered in this century, it is reasonable to assume that their total number is not much greater. About two hundred are recognized in the great galaxy in Andromeda, an almost identical twin of the Milky Way. No doubt they exist also in more remote galaxies, but cannot be observed because of their greater distance.

The one hundred-odd clusters in our galaxy form a system concentric to the Milky Way, but the volume they occupy is nearly spherical whereas the Milky Way is disk-shaped. The radius of this sphere is roughly 65,000 light-years, or more than twice the distance of the sun to the system's center. Accordingly, many more clusters are seen in the direction of the Milky Way nucleus than in the opposite half of the sky (since about three-fourths of the system's diameter lies in the former direction). As a matter of fact, this lopsided distribution gave the first hint that the sun is not located at the center of the Milky Way.

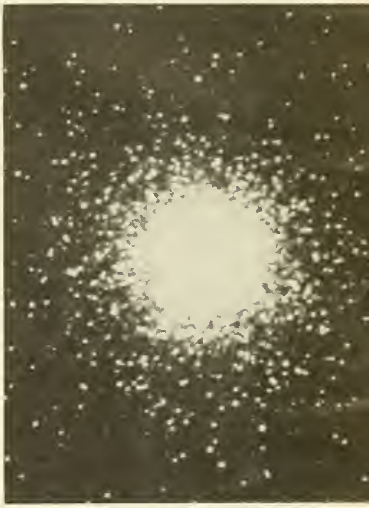
Individual clusters contain a minimum of 50,000 to 100,000 stars, the majority of which fill a roughly spherical space not more than thirty light-years across, with the remainder thinning out to perhaps fifty light-years from the center. Such heavy concentration suggests that distances between adjacent stars may be comparable to those between planets in the solar system. This, in turn, implies heavy gravitational effects, which can be counteracted only by fast rotation of the cluster as a whole (otherwise, the strong attraction between stars would cause the system to collapse toward its center). There is every reason to believe that the slight flattening evident in most globular clusters is caused precisely by this rotation.

These clusters are so far away that only their brighter stars can be distinguished. It is hardly surprising, therefore, that all cluster stars appear to be giants. If any ordinary stars, like the sun, are present, they are too faint to be seen. Since there is no theoretical reason to exclude such stars from these aggregations, it is quite possible that the total population of a cluster far exceeds present estimates, perhaps even by a factor of ten.

The presence of a majority of red giant stars and the total lack of interstellar gas within the cluster are interpreted as signs of old age, in accordance with current theories on the evolution of star systems. There is an uncanny resemblance between globular clusters and small elliptical galaxies — also believed to be very old. Both in brightness and in the types of stars that they contain, the two are nearly identical. Even the smallest elliptical galaxies are much larger, however, and the apparent similarity of these two classes of objects may be fortuitous. On the other hand, if there is a link between the two, no satisfactory explanation has yet been devised to account for this puzzling relationship.



Nineteenth-century drawing of the cluster M92 showed a false S pattern.



Twentieth-century photograph of the cluster M3 shows its tidy globe shape.

THE SKY IN DECEMBER

From the almanac:

Full Moon	December 2, 11:25 P.M., EST
Last Quarter	December 11, 4:39 A.M., EST
New Moon	December 18, 5:47 A.M., EST
First Quarter	December 24, 9:30 P.M., EST

The sun will reach the winter solstice December 21, at 3:27 P.M., Eastern Standard Time.

For the visual observer:

Mercury, in the morning sky (−0.5 magnitude), will rise an hour and a half before the sun on December 1, and forty-five minutes before the sun on December 15. Except for the first few days of this month, its proximity to the sun will interfere with observation.

Venus (−3.7 magnitude) will be conspicuous in the evening sky. Low in the southwest at dusk, it will set at approximately 7:15 P.M., local time, on December 1, at 7:45 P.M. on December 15, and at 8:15 P.M. on December 31.

Mars, in Gemini, will be at its brightest for the year (−1.3 magnitude) at the end of December. On Christmas Day it will be at a distance of 56 million miles from the earth, its closest approach since 1958 (see below). South of Castor and Pollux, it will rise at 7:00 P.M., local time on December 1, at 5:45 P.M. on December 15, and just before sunset on December 31. It will pass nearly overhead at 2:30 A.M. on December 1, at 1:30 A.M. on December 15, and midnight on December 31, and still be high at dawn.

Jupiter, in Sagittarius (−1.4 magnitude), is approaching its superior conjunction with the sun and will be visible only in the early part of December, setting at about 6:30 P.M., local time, on December 1, and at 5:45 P.M. on December 15. A clear view of the southwestern horizon will be required for observation. By the end of the year, the planet will set with the sun and will be lost in its glare.

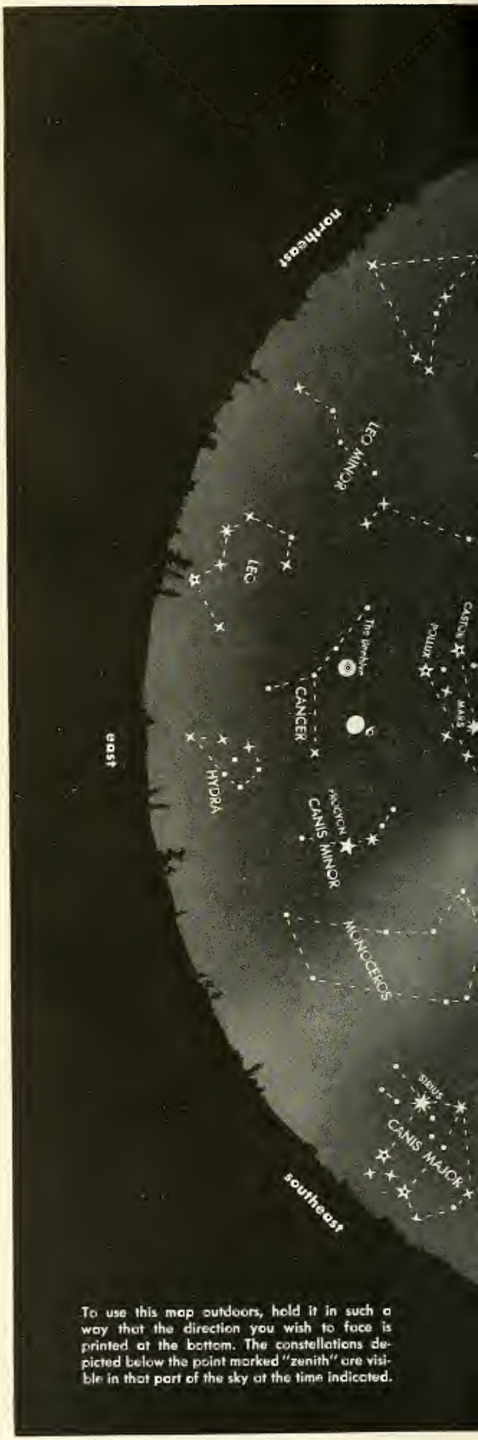
Saturn, in Sagittarius (+ 0.8 magnitude), will be found to the east of Jupiter. Like Jupiter, it will be too close to the sun for easy observation at year's end. It will set at 7:15 P.M., local time, on December 1, at 6:30 P.M. on December 15, and at 5:30 P.M. on December 31.

Two meteor showers may be expected in December: the Geminids on December 13, with a maximum rate of 50 meteors per hour, and the Ursids on December 22, with a maximum rate of 15 per hour (for a single observer).

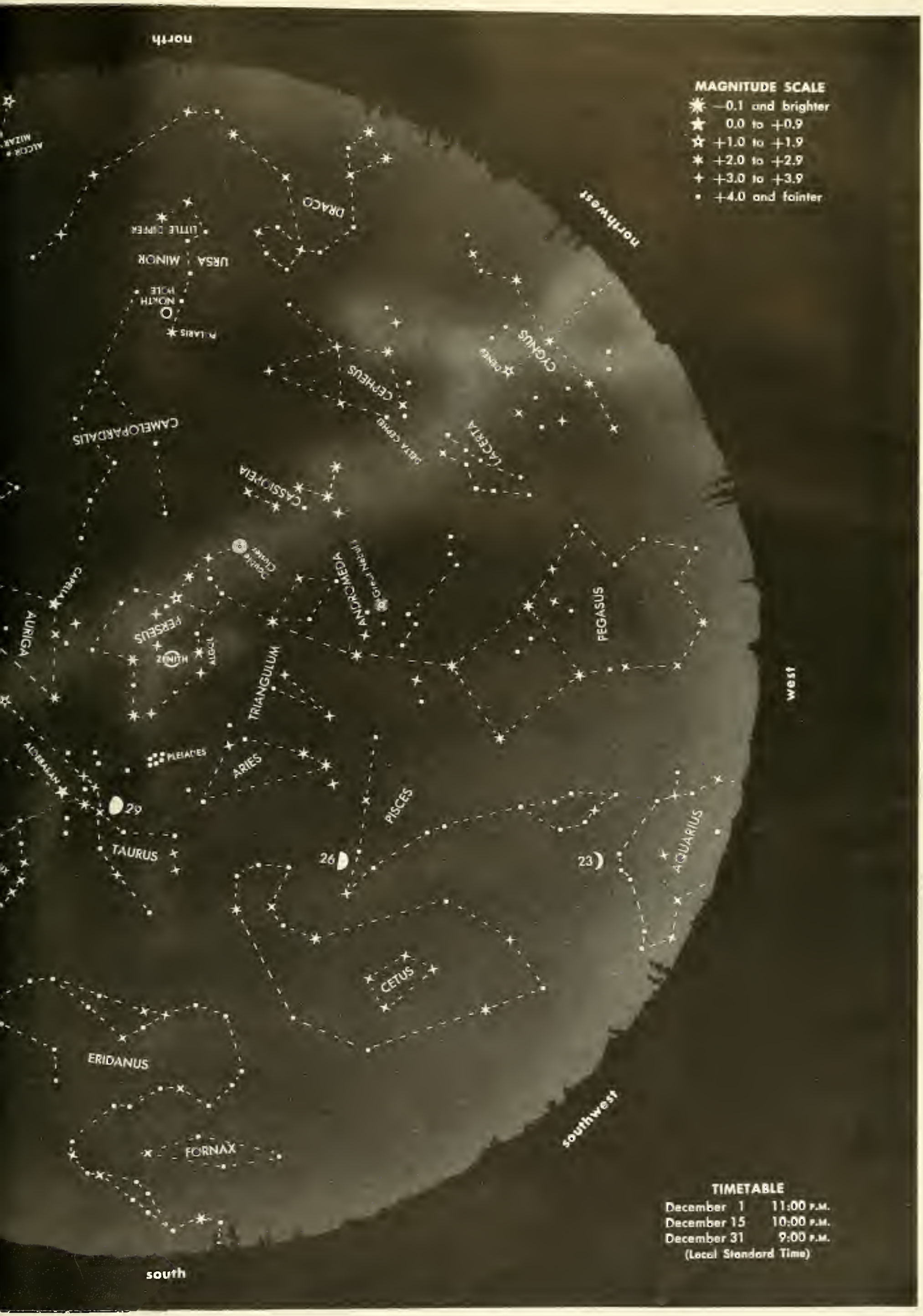
Close approach of Mars:

Once every two years and fifty days, approximately, the planet Mars reaches a point where it is closest to the earth. However, the orbits of Mars and the earth are not exactly circular, and their distance at close approach varies appreciably (between 34.6 and 62.9 million miles). In this light, Mars' approach in 1960 is not a particularly favorable one for astronomers. The shortest distance between the two planets is near its minimum value every fifteen or seventeen years. It was during such a close approach, in 1877, that the two satellites of Mars were discovered by Asaph Hall at the U.S. Naval Observatory. In the present century, these minima have occurred in 1909, 1924, 1939 and 1956: the next one will not be until 1971. Nonetheless, Mars—high and bright in the night sky—will be *the* spectacular object for amateur observers this winter.

The former Astronomy Editor for NATURE Magazine, MRS. GOSSNER, continues in that role for NATURAL HISTORY.



To use this map outdoors, hold it in such a way that the direction you wish to face is printed at the bottom. The constellations depicted below the point marked "zenith" are visible in that part of the sky at the time indicated.


north
MAGNITUDE SCALE
—0.1 and brighter
0.0 to +0.9
+1.0 to +1.9
+2.0 to +2.9
+3.0 to +3.9
+4.0 and fainter
ALCOR
MIZAR
DRACO
LITTLE DIPPER
URSA MINOR
NORTH POLE
POLARIS
northwest
CYGNUS
DENEB
CEPHEUS
DELTA CEPHEI
LACERTA
CAMELOPARDALIS
CASSIOPEIA
Double Cluster
Great Nebula
ANDROMEDA
CAPELLA
AURIGA
PERSEUS
ZENITH
ALGOL
TRIANGULUM
PEGASUS
west
ALDEBARAN
PLEIADES
ARIES
29
TAURUS
PISCES
26
23
AQUARIUS
CETUS
ERIDANUS
FORNAX
southwest
south
TIMETABLE
December 1 11:00 P.M.
December 15 10:00 P.M.
December 31 9:00 P.M.
(Local Standard Time)

REVIEWS *Continued from page 7*

cene epoch of the Cenozoic era are unaccountably skipped.

Patricia Lauber's *All About the Ice Age* is one of the Random House "Allabout Books." This series, one gathers, is far from even in quality, but the present volume merits favor. Miss Lauber has shown that an interesting, accurate book for young people can be written that covers all sides of a controversial scientific topic and presents alternate views in proper perspective; and I think we should be right in relating her success to the relative narrowness of her theme. The text reads smoothly and is well organized, and the diagrams further assist the reader. A fine book.

John Imbrie

Botany and Ecology

The modern "'tweenager," as children 12–16 years old may be called, is too frequently in an educational dilemma. He may be interested in several aspects of science, but finds that he either cannot take all the courses he would like or that the courses do not meet his needs. To some degree, a solution for this dilemma is available in today's variety of books on almost every subject, written from almost every point of view. The seven books selected here represent only a scattering of points along the spectrum of approaches to science in current books. Generally, these selections are of higher quality. Some, however, are typical of the many books—often of extremely attractive format—that are marred by inaccuracy, incompleteness, and lack of purpose.

One is a book of the survey type. Since every science is made up of a number of areas of specialization, some are well known while others are almost unpublicized. The survey approach discusses all or a number of these areas for a given science. Margaret O. Hyde's *Plants Today and Tomorrow* (Whittlesey House) is one of the best of these.

Mrs. Hyde's book properly depicts botany as a modern, dynamic, experimental science. Botanists are shown to be searching for clues to new food sources, testing the effects of radiation on plant growth and physiology, seeking new antibiotics and drugs, investigating the causes and cures of plant diseases, isolating hormones and developing growth regulators, determining environmental controls over plant growth and methods of manipulating these factors for human benefit, and even experimenting on plants in artificial atmospheres to simulate conditions in spaceships and on other planets. Leading plant scientists are introduced by name and their researches are clearly described in a succinct style. This book should be read by every young man or woman interested in biology, as well as by any adult who wishes to learn more about the activities of modern botanists.

The historical approach to a science is typified by *Plants That Changed The World*, by Bertha S. Dodge (Little, Brown). The book considers only that phase of botany known as plant exploration, telling the story of the location, exportation, cultivation, and exploitation of several well-known plants. Although the text is authoritative, it is so burdened with details of personaliti and anecdotes that one tends to lose i terest even in the accounts of such i portant products as rubber, breadfrui cacao, and quinine. The final chapte "A Look Ahead," attempts to indica the opportunities for future plant expl ration but it lacks enthusiasm and pr sents little challenge to the student.

How to Grow House Plants, by Mil cent E. Selsam (Morrow), is an exa ple of the "applied" approach to t discussion of science. While the prin pal aim of this book is to provide info mation on the indoor culture of plant it is also an excellent introduction basic plant biology: not only are t "cookbook" methods of plant care give but the reasons for each recommend tion are clearly presented.

Turning now to ecology, John H laby's *Nature and Man* (Roy), typifi the scatter-gun approach. The auth jumps into his subject with very litt advanced preparation. As he continu his jumping, he keeps the reader abrea of the text by defining words and e plaining concepts as they arise. Hill by's book also exemplifies the narrati first-person method of writing, for t author is widely traveled and seiz every chance to develop his theme by lating it to some incident from his o journeys. Although the book includ some interesting tales of African adve ture, it contains numerous errors: "T elephant is the biggest animal on earth some curious obiter dicta: "Original there were no . . . mammals of any ki in Australia," and some very unsou discussions of ecology. Indeed, it is hit-or-miss in its presentation of e logical principles as to be more da aging than constructive.

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Another ecology book, Ted S. Petit's *The Web of Nature* (Garden City), illustrates the developmental approach to a subject. This is the arrangement used in most textbooks: one is first exposed to a number of basic facts that are necessary to the understanding of the more complex matters in the main text. Petit's book is an introduction to community ecology. Accordingly, it begins by presenting a highly selective assortment of facts regarding plant-animal communities, embedded in a lavish display of full-color illustrations. The greater portion of the book is a superficial survey of the principal natural communities of North America—tundra, forest, grassland, and desert. Unfortunately, the book contains a number of ambiguous and indefinite statements and many oversimplifications.

Henry B. Kane's *The Tale of a Meadow* (Knopf) draws the reader into a day-by-day investigation of the activities of animals and plants in a small New England meadow. Mr. Kane tells his story through the eyes of a young boy. It is a convincing text, enhanced by a number of spectacular photos taken by the author. The reader participates in every experience, from the observations of a chipmunk scampering through an old stone fence row to the investigation of the depth of a snake's concentration. Although the book contains a great amount of information on botany, zoology, geology, and ecology, the reader never feels that he is being "taught"—he is always "discovering" information. One ends up feeling that it would indeed be wonderful to observe a meadow or forest of one's own in the same way that the boy in Kane's excellent book has observed his.

Another approach to science is through the study of a current problem. Conservation is often publicized by this technique—which all too frequently involves a tear-filled, scaremonger treatment. However, Ivah Green's *Wildlife in Danger* (Coward-McCann) stands at the opposite end of the rank. It fails either to excite one about the danger to wildlife, or to incite one to action to thwart such danger. *Wildlife in Danger* discusses nineteen birds, eight land mammals, and two marine mammals. The appearance of each is given, together with data on its habitat, habits, range, food, reasons for reduction of its numbers, estimate of its present populations, areas in which it is protected, laws for its protection, and methods employed to assist the recovery of some species. Most of the chapters do not offer any constructive suggestions for action in order to preserve or assist the species that is alleged to be in peril—in the discussion of the flamingo, for instance, the most positive position taken is "These beautiful birds need our protection." The book is further marred by various erroneous reports—at least six of the twenty-nine species listed as "in danger" are already extinct—spineless statements, and a general lack of purpose.

JACK MCCORMICK

Zoology

IT IS SURPRISING to see, among the numbers of young people's zoology books that are published each year, how few strike a proper balance and achieve some kind of consistency in their merits. We find that the pictures in one book are enchanting, but that the text is impossible to follow—or vice versa. We find some authors assuming that, because the reader is young, he must be written down to, and so on. What we hope for—whether to review or to read—is a book whose author selects his subject carefully, avoids the common error of including too much, organizes and presents his material clearly, and assumes that his reader is intelligent. Of the baker's dozen of books reviewed below, only three fulfill these requirements.

Four books on animal habits and behavior are available for various ages. The youngest readers will find a few examples of behavior in George Mason's *Animal Habits* (Morrow) under such categories as instinct, intelligence, nest-building, affection and grief, and several others. Unfortunately, the choice of activities that Mason describes is influenced by his own observations rather than by their significance, so that the book is merely anecdotal. We are told about a cat that opens a latch door, for example, and a crow that steals jewelry. These actions—which Mason explains as due to trial-and-error learning in the cat and to the crow's attraction to bright objects—are certainly insufficient to illustrate things as complex as animal intelligence. It appears that the author is afraid to overwhelm his reader with substance and, therefore, offers gloss. Many students of animal behavior will also regret that the book opens with a chapter on instinct: to "explain" certain behavior as inborn may tend to preclude further investigation of that behavior. However, Mason should be commended on one point—he stresses that there is no need to ascribe human characteristics to animals.

The wealth of the past

lies no deeper than the archaeologist's spade. A trial trench through an olive grove uncovers clay tablets with an inventory of King Nestor's worldly goods. Excavation for a modern sewer brings to light five masterpieces of ancient Greek sculpture. A great mound in Turkey yields the rich grave furnishings of a princely burial.

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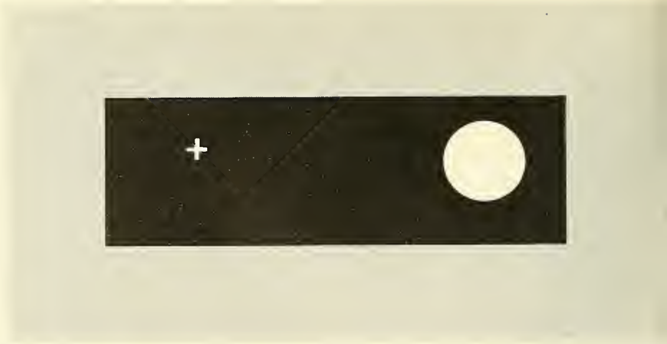

DO-IT-YOURSELF proof of the difference between cone and rod vision is shown in *The World of Feeling*. Close one eye, look at cross and bring page closer. A critical distance, the large white spo will "disappear" to daylight-blind rod

In another book by the same author, *The Bear Family* (Morrow), he leaves the general survey approach for a more specific subject: the habits of black, brown, grizzly, and polar bears. This book mixes technical information and anecdotes in a somewhat contradictory blend. A reader seriously interested in the bears' way of life will find the anecdotes bothersome and the technical information inadequate, while the reader interested in stories of Mason's experiences with bears will probably be bored by the technicalities.

Strange Travelers, by Sigmund Lavine (Little, Brown), surveys animal migrations, briefly describing periodic, sporadic and accidental movements over land, sea, and air among a great variety of creatures, from prehistoric camels to whales. Although the book is well written, informative and accurate, I wish that the author had covered fewer animals and described each in greater depth. As it is, he skims over most of the interesting problems posed by migrations: how groups assemble, the physiological changes within the animal, and the like. I also object to the word "strange" in the title. These happenings are *not* strange or peculiar: they are part of normal behavior among a vast array of living forms with many different adaptations for survival. Interesting, yes; freakish, no: I think it is coddling the reader in a most unfortunate way to suggest that they are.

For the 12–16 age group, I highly recommend J. D. Carthy's *The World of Feeling* (Roy). This book, which compares the sensory systems in man and animals, is in fact one of the finest studies available on sensory functions. Carthy has selected the main features of each system and, while he does not pause unduly over the more complex details, his information is everywhere abreast of the finest and most recent research. It is also stimulating in that he goes beyond the old concept of five sens organs, discussing the other senses o the body—those of heat, pressure, col and balance—and the specialties pecu iar to certain animals, such as the sens tivity to water currents in fish. All thi is done in a style that both assumes th reader to be intelligent and treats hi as an adult—in which spirit a short lis of pertinent books for more advance reading is also included. One only re grets that the illustrations are n crisper and done in greater detail: som are difficult to follow unless the reade has a background in physiology.

WITH the ever-increasing interest i oceanography, the reissue of W Maxwell Reed's book, *The Sea for Sa* (Harcourt, Brace), is a timely actio Revised by Paul Brandwein, a scienti active in bringing modern biology t high school students, the first half of th book is devoted to oceanography—the ries of water movement, tides, wave and depths, all sprinkled with historic accounts of exploration and great u heavals. The second half discusses m rine biology, from minute bacteria an algae to the great whales. These latt chapters were written by Wilfrid Bro son, who unfortunately suffers from a anthropomorphic tendency when d scribing many animals. But if the read can overlook this failing, he will find vast amount of information about s life, necessarily brief and often supe ficial, but serving to stimulate furth reading. The photographs, collected fro many sources, are beautiful—in fac superb—and an excellent index mak this book most useful as a reference.

Science on the Shores and Banks, l Elizabeth Cooper (Harcourt, Brace has a different aim—that of instructi in the finding and collecting of livi forms. Naturally, in a book of this so considerable emphasis is placed equipment, and there are suggestio on how to adapt ordinary household articles for collecting. But habits and life histories are also discussed, so that the young collector will learn more about the biology of animals and plants than would be readily apparent from his own observations. My major criticism of this book concerns its organization: it would have been far better had Mrs. Cooper divided the book into two parts, one concerned with fresh water, and the other with marine forms. As it is, the reader does not know the book's scope at the outset or, once he realizes this, where to look for treatment of a specific subject. Since the book is so poorly organized, it will never serve as a field guide and will stay in the library, to be read only between collecting trips.

For those who prefer collecting on land, Percy Morris has offered a companion volume to his other books on frogs, toads, salamanders, and snakes by publishing *The Boy's Book of Turtles and Lizards* (Ronald). The animals are neatly catalogued in groups, which are introduced by discussions of general anatomy and evolutionary history. As to individual forms, Morris covers identifying features, range, distribution, size, habitat, source of food, and, wherever known, something of the breeding habits. He assumes that his reader already knows how to collect specimens but gives information on their care once they have been captured. Minor errors, as when the pelvic girdle is mentioned where the pectoral girdle is meant, do not detract from this excellent book. The photographs are very good.

Younger and older amateur entomologists will enjoy two books about insects, *Dragonflies and Damselflies*, by Mary Phillips, and *Grasshoppers and Crickets*, by Dorothy C. Hogner (both Crowell). The latter book, intended for young children, is delightful—clearly written, informative, factual, and charmingly illustrated. It discusses the anatomy of grasshoppers and crickets and their way of life and it tells how to find and keep them. Some of the anatomical descriptions, in which technical terms are employed freely, should serve as models for many who write children's books. Mrs. Hogner does not feel it is necessary to draw poor analogies nor to be humanistic in her exposition. Where analogies *are* drawn, as in a comparison of chitin with bone, they are presented in such a way as to inform, not mislead. Nor does Mrs. Hogner lack imagination: she reminds children, for example, of the Chinese custom of keeping crickets as pets, and she may start a rage for cricket-keeping among the younger set.

For the older child with a serious interest in entomology, *Dragonflies and Damselflies* is a well-written, informative book. There is much technical information on the biology, life history,

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habitat, and methods of collecting and preserving these magnificent, iridescent insects. The back pages contain a good listing of other books on insects, and the index makes this volume valuable as a reference source.

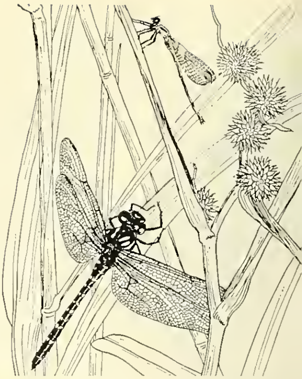
The next four books cannot be recommended, but they should be mentioned because they are more representative of the over-all level of juvenile science books than the comparatively laudable efforts discussed above. They are representative not only in being bad, but also, on the whole, in the particular faults they embody.

Peter Farb's problem, in *The Story of Butterflies and Other Insects* (Harvey House), is an overwhelming variety of material. Any author, if he is to bring order into this chaotic welter, must show some ability to select. But Mr. Farb does not. He is far too ambitious, with the paradoxical result that instead of presenting everything, as he had intended, he gives only a scrap heap of bits and pieces. Further, the style is written "down" in a misguided attempt to simplify things. The illustrations are poor and the colors of the butterflies incorrect.

Helen Cruikshank's *Wonders of the Reptile World* (Dodd, Mead), on the other hand, suffers not from an excess of purpose but from its lack. Her aim appears to have been to combine the fossil history of reptiles with the biology of living reptiles. Actually, both are badly treated, because the author has not been able to decide how to proceed. She will state a fact and never develop it. She will concentrate on highly specialized, rather than typical activities. Her book is full of platitudes and weak statements such as this one: "Most turtles have a keen sense of smell. No doubt this helps them find food." Enough.

Another book in the publishers' same "wonder" series, *Wonders at Your Feet*, by Margaret Cosgrove (Dodd, Mead), falls into a common error we have already noted—anthropomorphism. This book is saccharine, humanistic, and rife with emoting insects. It is also so erratic as to be impossible to follow, springing from one topic to another in as little time as it takes an insect to beat its wings.

Perhaps the best of these bad books, although still a very scrappy one, is C. L. Ripper's *Ground Birds* (Morrow), which discusses the habits of the woodcock, road runner, ovenbird, owl, bobwhite, whippoorwill and snow bunting. This embraces, as one can see, a wide range of habitats, and the reader wonders what rationale lies behind the selection. His doubts are fortified when, on opening the book, he finds drawings of an albatross and heron and reads that, while these are typical birds, they



DAMSELFLY, *top*, folds its wings in res
dragonfly, *below*, rests with them sprea

are not ground birds and are used onl
to introduce ground birds! The wor
is obviously organized round the draw
ings (done by the author), and the te
consists of the author's own field o
servations. Alas, there is a good de
more to zoology than that!

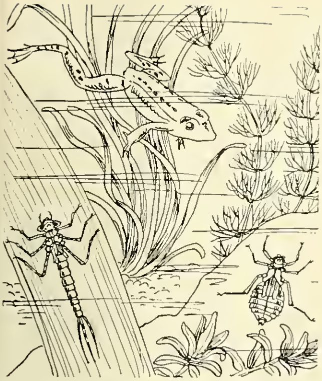
In sum, of the books reviewed, thre
are considered to be very good: *Th*
World of Feeling, The Sea for Sa
and *Grasshoppers and Crickets*. This
all too few, but at least these three de
onstrate that it is possible to wri
clearly about very complex subjects a
be interesting and exciting as well.

EVELYN SHA

Anthropology

Any new book in the field of anthr
pology should take advantage
new knowledge—that is, it should use t
wealth of information that has come o
way from research these last twen
years, whether the researchers be et
nologists, archeologists, historical a
thropologists, or whatever. Furthe
since anthropology is a science, such
book's facts should be accurate. Finall
both the writing and the illustratio
should be worthy of the minds to whi
they are directed. It would seem unne
essary for any reviewer to stress the
fundamental principles, were it not f
the foolishness to which so many ch
dren's books in America have descende

The benighted science of archeolo
makes a four-part case for our dossi
Ever since Schliemann sought Tro
whole armies of professional hacks ha
received substantial remuneration f
describing the labors of the archeol
gist. How many times, on their page
has Arthur Evans "panted" over Kn
sos, Howard Carter "gazed with aw
at Tutankhamen, Stephens and Cath
wood "sweated" at Uxmal, and po



Nymphs of damselfly, *left*, and dragonfly, *right*, also appear in the Phillips book.

De Perthes "begged for understanding!" It is all a horrendous spectacle.

The first two of these form part of a desperate series called the "Allabout Books" (Random House). Supposedly aimed at the 10–14 age group, they are described in *The New York Times* "Book Review" as "written by authorities [sic] in each field . . . lively and informal in style, but not superficial . . . won an enthusiastic audience among fact-hungry young people. . . ."

Nothing could be further from the truth regarding the two examples before me. *All About Archaeology*, by Anne Terry White, a housewife turned author, simply tells abbreviated adventures to the rhythm of a metronome. It contains little on the subject as a science and would give one the impression that nothing of interest has happened in the field in the last twenty years. Its companion volume, *All About Prehistoric Cave Men*, is the work of Sam and Beryl Epstein, a team that has composed over fifty books for "young readers." Here is a book "All About" prehistoric man that does not mention the Java man or South Africa, and discusses Peking man without mentioning Franz Weidenrich, the great student of the subject. One illustration shows a group of Neanderthals stabbing at a large wooly mammoth in an Ice Age setting; animals and trees are appropriate to the climate, but the Neanderthals stand about half-naked, as if they were too stupid to dress for the weather. The Neanderthals would turn in their Stone Age graves if they could see this book.

Secrets in the Dust (Dodd, Mead), a more pretentious effort, is written by a man described as ". . . a New Yorker with a great variety of interests." Raymond Holden tells his adventure stories with more detail than do some others, but they are the same tales. The "panting, gaping, awestruck, sweating" heroes of decades ago all still rush breathlessly to their Nemesis. Holden's book is subtitled "The Story of Archaeology," leaving us to infer from its gaps that the story of archeology excludes the "father of archeology," Sir Flinders Petrie (he was not one to "pant") or the present dean of archeologists, Sir Mortimer Wheeler (hardly one to be "awestruck"). The Dead Sea scrolls, the "Solar Boat" of Khufu, the decipherments of Michael Ventris, and the discoveries at Nippur, Jericho, and in the Negeb—all within recent years—are given no place.

The best of the lot, *Man in the Making* (Putnam), is written by another educated housewife, according to the jacket blurb—Estelle Friedman. More carefully researched than the others, it nevertheless betrays a naïveté that makes it a weak reed for a child to lean on. The re-creation of past life from skeletons is exemplified by those attempts at reconstruction from odd pieces of bone carried on years ago by Cuvier and by Sir Arthur Keith, as though prehistorians continually work with such jigsaw puzzles. Then there are such statements as "If a tool for scraping animal skins is discovered, the archeologist can be fairly sure that the clothing must have been made of animal skin stitched together." As one who has worked on just such problems, I should like to ask what stitching has to do with scraping. So it goes—there is some good material here, but it is buried in the ash of misstatement and error. The illustrations, by the way, are terrifying.

All details of inaccuracy and superficiality aside, the essential point is that these books are mediocre creations of amateur "scientists" who barely touch upon what is an immense and, for that matter, a practical subject. The vast perspective of man's story on earth, his physical evolution, the dynamics of his cultural beginnings, the character of his ancient societies, the achievements of his developing mind, and the continuous experiment, failure, and success that characterize his actions in nature are meaningful topics, which archeology—as a science—examines.

If these authors had chosen to look, they would have found that library shelves are stocked with hundreds of monographs and thousands of articles describing archeological findings throughout the world. They might have learned of such techniques as seriation, Carbon 14 dating, pollen analysis, aerial photography, qualitative analysis, serology of prehistoric skeletons, obsidian dating, skin diving, and dozens of others that are at the service of archeologists. Modern archeology is no more pedantic than the primitive archeology our authors so love to describe. It is just more complex, more meaningful, and less amenable to television-style writing.

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Two books on Indians of the New World appear to have been aimed at a somewhat higher level. Regrettably, they only exemplify the same faults.

The first is *The Inca*, by Sonia Bleeker (Morrow). The jacket blurb tells us that Miss Bleeker has written fourteen books on Indians. Her method of working consists of getting the basic source books for the tribe involved and putting down a straightforward, factual account in short paragraphs and simple sentences. The result is a static outline of a culture seen externally and about which the author has little or no point of view. Miss Bleeker's method thus runs counter to the purpose of modern anthropology: to study a culture from the inside and see its components in their dynamic and living interrelationships. Then, too, the strictness with which the author confines herself to the culture involved gives the impression that the culture flourished in isolation. In *The Inca*, nothing of the rich archeological background—the very foundation upon which Inca civilization was reconstructed—is mentioned in the text. This is like discussing medieval Italy without mentioning classical Rome—almost impossible to do, but Miss Bleeker does it. We must remember, also, that the densest populations in ancient Peru were in the irrigated valleys of the desert coast. Miss Bleeker's account gives an erroneous idea as to just where the Peruvian centers of culture were located. Because of her reliance on valid source books, the author's own errors are minimized. But the book is a literary corpse.

A series of magazines and books put out by American Heritage Publishing Company has sold like hot cakes almost since its inception. The formula is to use plenty of original illustrative material, combined with short, but not too elementary, texts, ostentatious bindings—and presto! Whatever the text, no one can ignore fine reproductions of original paintings, drawings, and photographs. Inspired by their success, the publishers have swept into the children's field as the American Heritage Junior Library. An example before us is entitled *Indians of the Plains*, but it could better be called *Blood on the Plains*, for a more gory book has yet to be written.

This is, in its way, a most curious venture: it purports to inform young minds about some American Indians, and yet its bias is overwhelmingly hostile to them. This is most evident in the illustration, which relies largely on the work of the white artists of the nineteenth century, but it affects the text as well. "Tomahawks and scalping knives," for instance, are given ten pages and a wealth of bloody detail, while "tribal law" is dismissed in a page. And yet the first half of the book pretends to treat of the Indians in themselves. When, in the second half, we turn to "the coming of the white man," the text merely recounts epic after sanguinary epic—the Minnesota Massacres, Custer's Last Stand, and the rest. There has been nothing like it since the Columbian Exposition of 1893.

The reader soon wonders if there were any human beings among these savages. Did they have different societies and contrasting cultures? (The book passes very lightly over the sedentary tribes.) Did they ever live in harmony with man and nature? (After all, most peoples do, or at least have done so.) Did they enjoy being Indians? But, then, if it answered such questions perhaps the book wouldn't sell.

Perhaps I may draw a final example from my own experience. I had to examine a textbook for high schools—". . . the last word in the right book for American children . . ." said the publisher, backed by a dozen or so educational experts and their house organs. Thumbing through its colorful pages, I came to Greece. Here were nine pages given over to the wars of Alexander; as for Socrates, he rated one sentence, and Aristotle none at all! What responsibility this represents! What a splendid foundation for America's creative leadership! It seems unfortunately clear that it is not the child that must grow up, but the publisher.

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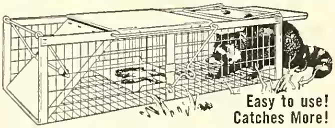

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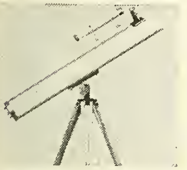

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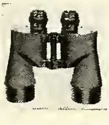

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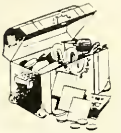

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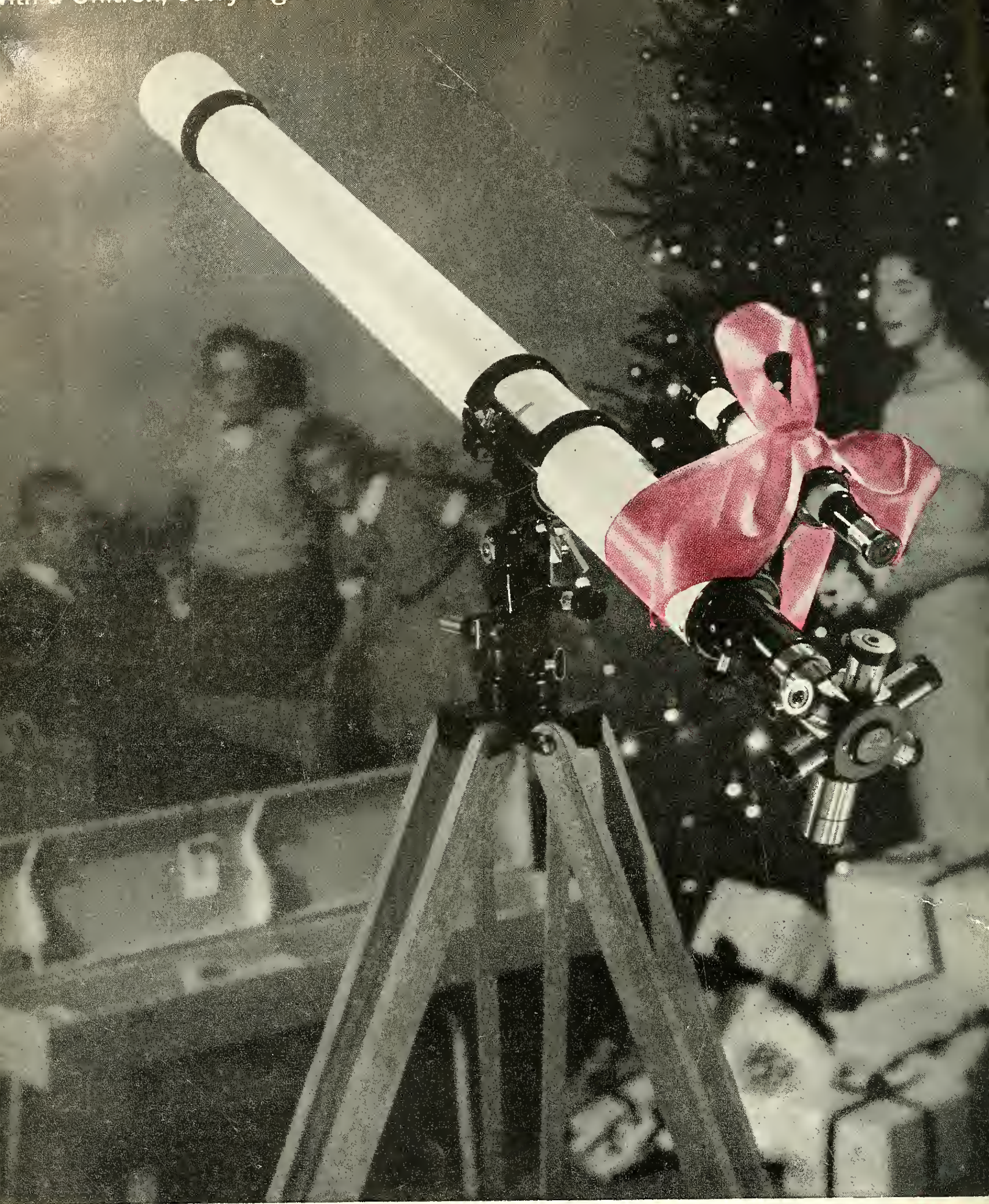

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